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follows

LAYING OUT FIELDS FOR TRACTOR PLOWING

TRACTOR plowing usually requires methods of laying out the land different from those followed when plowing with horses and an ordinary plow.

Farmers plowing with a tractor for the first time are often at a loss for the most satisfactory method of laying out their fields.

A scheme admirably suited to one size and type of tractor under a certain set of field conditions would not be satisfactory for some other size and type under different conditions.

This bulletin embodies the descriptions of methods found best suited to their conditions and recommended by a majority of several hundred tractor owners who have reported their methods and experiences.

Among these will be found methods of laying out land suited to nearly every farm in this country and to fields of different shapes.

Office of the Secretary

Contribution from the Office of Farm Management

H. C. TAYLOR, Chief

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LAYING OUT FIELDS FOR TRACTOR PLOWING.

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FACTORS TO BE CONSIDERED IN MAKING PLANS FOR TRACTOR PLOWING.

FARMERS who plow with tractors desire first of all to lay out their fields so that they can do a high-class job of plowing over the entire field with the minimum use of a horse-drawn plow in starting and finishing the work. It should usually be possible to open up a field without the use of horses, but it will not often be possible to finish the ends and corners as satisfactorily with the tractor as with horses; many farmers, regardless of the method followed in plowing with the tractor, use horses for finishing up the corners and plowing the last few furrows near the fences.

Then the plowman wishes to reduce to a minimum the time spent in turning and in running with the plows out of the ground. Time spent in useless turning or traveling long distances across the ends with the plows out reduces by that amount the number of acres which can be plowed in a day, making the tractor that much less efficient. The ideal in this respect would be for the plows to be in the ground all the time that the tractor is moving, but the quality of the plowing can often be improved by spending a little more time in turning or running with the plows idle. However, on every job

there is a point beyond which it will not be profitable to go in sacrificing speed for quality of work.

Making short turns is awkward work for most tractors, and where such turns are necessary the operator often has more or less difficulty in getting the outfit in the correct position for starting into the furrow at the right point. The type and size of the tractor will have much to do with the ease in making short turns, but short turns are always troublesome. The plowman should decide before he starts work on his field to what extent he can afford to drive the outfit with the plows idle, so as to make a long, sweeping turn instead of a short one, or just how much he can sacrifice in the quality of his work in order to avoid awkward turns.

While it may pay to make some effort to avoid short turns with a large, cumbersome outfit, it should be borne in mind that the loss of time and fuel due to making long idle runs across the ends of the field with an outfit pulling several plows is just as serious as it is with the small, easily handled tractors. From the standpoint of time lost in idle running, the size of the tractor and the number of plows pulled should be considered only with reference to relative difficulty in making the short turns in starting or finishing the lands. For instance, it might pay to lay out in five lands for a 4-plow outfit a field that would have been plowed in six lands with a 2-plow outfit, but it would rarely, if ever, pay to lay it out in only three lands for the big outfit.

Some tractors turn more easily in one direction than another, and with an outfit of which this is true it may pay to lay out the fields accordingly. If the outfit is not equipped with self-lift plows, a certain amount of time must be taken to stop the tractor and lift the plows out by hand, and this time may be so great as to make it more profitable to adopt a method by which the plows will have to be lifted a very few times, if at all.

In deciding how wide the lands are to be, the ease of handling the tractor and plows may not always be the most important thing to consider. In regions of heavy rainfall, it may be best to make narrow lands with frequent dead furrows and back furrows as an aid to drainage, while in more arid regions the reverse will be true. The contour of the ground or the shape of the field may be such as to determine almost entirely the method that must be followed in the plowing.

In short, many circumstances must be considered before deciding just what method would be best for a particular field with a particular outfit. Every job of plowing presents a problem of its own, and there can be no one best method for all cases.

The methods in general use can be divided into two general classes: (1) those in which **the plows are lifted** and **no plowing is done**

across the ends; and (2) those in which **the plows are left in the ground while going across the ends.**

The advantages of plowing by the methods of the first class are that the short, awkward turns are eliminated, except in some cases at the beginning and ending of the lands, and usually less space will be left at the corners to be plowed out with horses. It is generally possible also to do a little higher quality of plowing if the plows are lifted at the ends.

The advantages of the methods of the second class are that little or no time is lost in traveling with the plows out of the ground, and that ordinarily the number of dead furrows and back furrows will be considerably less. However, the turn at each corner must be made as short as possible if the space left to be plowed by horses is to be reduced to a minimum, and the land at the turning points, lying in diagonal lines extending from the corners of the field into the ends of the dead furrows or back furrows, is likely to be poorly plowed.

Taking the country as a whole, the methods by which the plows are idle across the ends are the more popular, but a large number of farmers have a decided preference for those by which the plows are kept in the ground continuously.

METHODS IN WHICH PLOWS ARE LIFTED AT THE ENDS.

If the field is rectangular and level, or nearly enough so that the irregularities do not have to be taken into consideration in laying it out, the choice between some method of the first class and one of the second class should depend on how hard it is to handle the tractor and plows in making short turns and how objectionable additional back furrows and dead furrows are.

WIDTH OF LANDS.

If a method in which the plows will be out of the ground in going across the ends is chosen, the first things to determine are how wide to make the various lands and how wide to leave the headlands on which to turn. The wider the lands are made the fewer will be the dead furrows and back furrows, but the greater will be the time consumed in idle running across the ends.

Some idea of the distance traveled with the plows out of the ground can be obtained by considering a specific case. Suppose a field 40 rods wide is to be plowed in this manner, one land at a time, and that it is laid off into six lands. Each land will be 110 feet wide. If the tractor is pulling three 14-inch plows, it will take 32 trips across the field to plow out each land. If we ignore the extra distances that the tractor must cover in swinging out of the furrow and back into it again, and in making the short or figure-eight turns in starting a back-furrow land or finishing a dead furrow, the average length of

travel across the ends—that is, the average distance in a straight line from where the plows are taken out of the ground to where they enter it again—is half the width of the land, or 55 feet. This makes 1,760 feet, or one-third mile for each land, or 2 miles of idle travel in plowing the entire field. If the field were laid out into 12 lands, each 55 feet wide, the total empty travel would be 1 mile, while if the field were laid out in three lands, it would be 4 miles.

The longer time necessary to make the difficult turns at each back furrow or dead furrow, which must be added to the time to travel these straight-line distances, will reduce the advantage of the narrow lands in this respect to a certain degree; but ordinarily a three-plow tractor, which has a comparatively short turning radius, and with which the making of short turns does not take a great deal of time, will plow a strip 40 rods wide laid out in six lands in about an hour's less time than if it were laid out in three lands. A 2-plow tractor will have to make one and one-half times as many trips across the field to plow a strip of a given width, and consequently the time lost in idle running will be about 50 per cent greater than with a 3-plow outfit. A 4-plow outfit will have to make only half as many trips as the 2-plow outfit, and so will lose only half as much time.

Each farmer must balance for himself this saving in time in making narrow lands, against the extra dead furrows and back furrows and the difficulties of short turns, and decide on the width of the lands accordingly. The most popular width seems to be from 100 to 200 feet. However, if the field has no irregularities, its entire width should be measured and divided up so that all the lands will be of the same width or nearly so.

HEADLANDS.

If the field is fenced on all sides, it will usually be better to leave an unplowed strip of uniform width clear around the field, to be finished after the body of the field is plowed out, than to have the lands extend to the fences on the sides. A headland extending clear around the field can be plowed by going repeatedly around the field until it is finished, without having to make any short, awkward turns.

If one end of the field is unfenced and the outfit can be pulled out into a road or lane or an adjoining field for turning, it may be preferable to plow up to the fences on the two sides, as the body of the field is being plowed, and leave a headland only across the end of the field which is fenced. Such a headland must be plowed with either a dead furrow or back furrow through the center, and more space will have to be left in the corners at the ends of the headland for turning the tractor.

The width of the headland will depend largely on the turning radius of the tractor with attached plows, and some farmers with very

easily-handled outfits do not leave over 15 or 20 feet; but any extra ground in the headland will be plowed just as quickly as if it were plowed with the body of the field, and plenty of room should always be left to allow easy turning and to get the outfit headed in exactly the right direction on entering the furrows. Also the wider the headland, the less is the tendency to go over the same ground repeatedly in turning at the ends when plowing out the body of the field, and consequently the ends will be packed less seriously. Headlands 50 or even 100 feet in width will usually be preferable to very narrow ones. With most tractors, the width of the headlands should be at least twice as great as the length of the outfit with the plows attached. Some farmers plow once around the field along the line of the headland, before starting on the body of the field. This gives a good guide for lifting the plows and letting them into the ground again at the ends.

SETTING STAKES AND MARKERS.

If the field is to be finished up in the best manner, with no irregular unplowed strips between the lands or at the edges, it is essential that care be taken to have the headland of the same width clear around the field, to have the distances measured exactly when starting new lands, and to have the first furrows as nearly straight as possible. A little extra time taken in measuring all the necessary distances and setting plenty of stakes for guides will nearly always be more than returned in saving time at the finish.

Most farmers will prefer to "step off" the distances rather than use any more precise measure, and, as far as accuracy is concerned, this will usually be satisfactory; but if the tractor pulls three or more plows, cutting a total width of 3 or 3½ feet or more, some effort should be made to have each distance an exact multiple of the total width of the plow, so that the last trip across the field will exactly cut out the land or finish it to the fence. This will do away with the necessity of making a trip across the field, probably over the plowed ground, to turn over a narrow strip possibly only a few inches in width. It is usually hard to handle the tractor in finishing out such a strip, and it takes at least as much time as it would to plow one of full width.

Some recommend that an A frame of the same width as the total width of the plows be used for measuring all distances. Then whatever the total width of the land is, the last trip will exactly finish it.

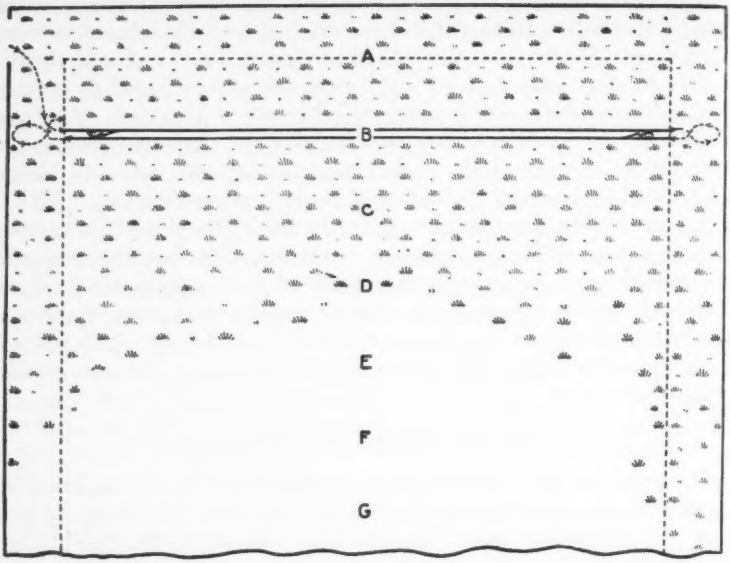

FIG. 1.—Method I, first stage: A headland all around the field; the lands to be plowed around back furrows. Note the loops made at the first turn in this and some succeeding methods, to avoid short turns to the right. The symbols representing plows show the direction in all the plans.

METHOD I.

This scheme and the one next described (Method II) are perhaps the simplest of all the schemes where the plows are kept out of the ground in going across the ends. By this method, the body of the field is plowed in successive back-furrow lands, beginning at one side of the field and finishing at the other.

The first step in this, as, of course, in all the following methods, is to measure off and mark out the distance to be left for headland, as indicated by the dotted line around the field in figure 1. Then, having decided upon the width of the lands, measure off the distance A B, half the total width of a land, and lay out a back furrow at B. Continue plowing around this back furrow as shown in figure 2 until the line at A is reached, and the land from A to C is finished. Next, measure the distance from C to D, making it the same as that from A to B, lay out another back furrow at D, plow

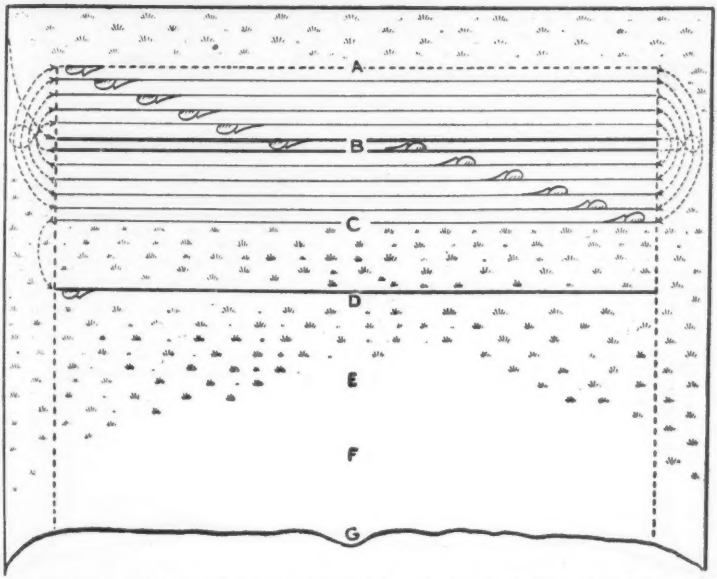

FIG. 2.—Method I, second stage: Another back furrow laid out at D in the field shown in figure 1, after the first land is finished.

out this land the same as the first one, and so on across the field. When the field is finished, there will be back furrows at B, D, F, etc., and dead furrows at C, E, G, etc. An open furrow will be left at A, and a corresponding one on the opposite side of the field. If the headland is plowed by turning to the right and throwing the earth away from the fence, these furrows will be filled and there will be no dead furrows or back furrows near the edge of the field.

The greatest objection to this method is probably the rather numerous dead furrows and back furrows. If the lands are made wider to reduce their number, the loss of time in traveling across the ends becomes serious. Also a series of short turns, as in figure 1, must be made each time a back furrow is laid out, and with some outfits this will be a rather weighty objection.

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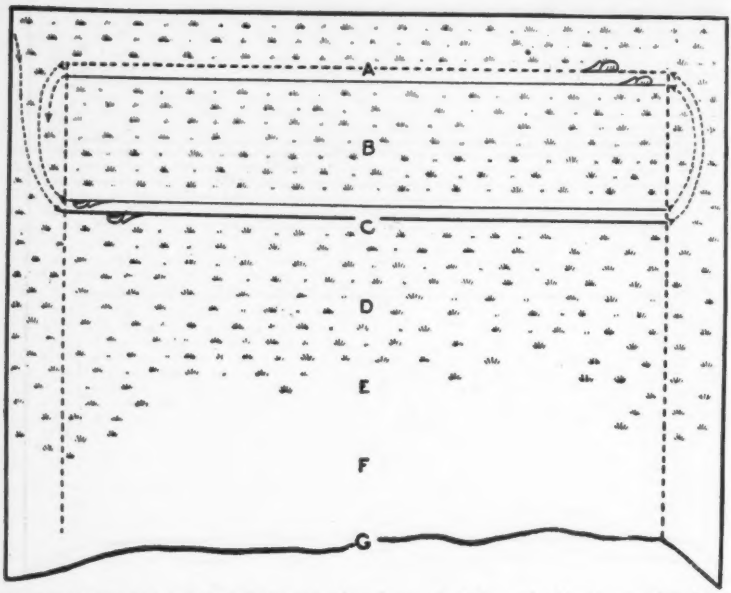

FIG. 3.—Method II, first stage: This field is to be plowed out to dead furrows by plowing around the lands The first completed land is shown in figure 4.

METHOD II.

By this scheme each land is plowed out to a dead furrow instead of being plowed around a back furrow as in Method I.

Measure the distance from A to C, figure 3, which is to be the entire width of the land; set stakes along a line through C and parallel to the line of the headland through A, and start the land by plowing out this line through C, turning to the left and coming down along the line of the headland at A.

Continue to plow around the land shown in figure 3 until it is plowed out to a dead furrow at B. Then measure the distance from C to E, making it the same as from A to C; plow through the line at E and come back along the line at C, as indicated in figure 4, making a back furrow here; plow out this land to a dead furrow at D, and so on across the field. When the field is finished there will be dead furrows at B, D, F, etc., and back furrows at C, E, G, etc.

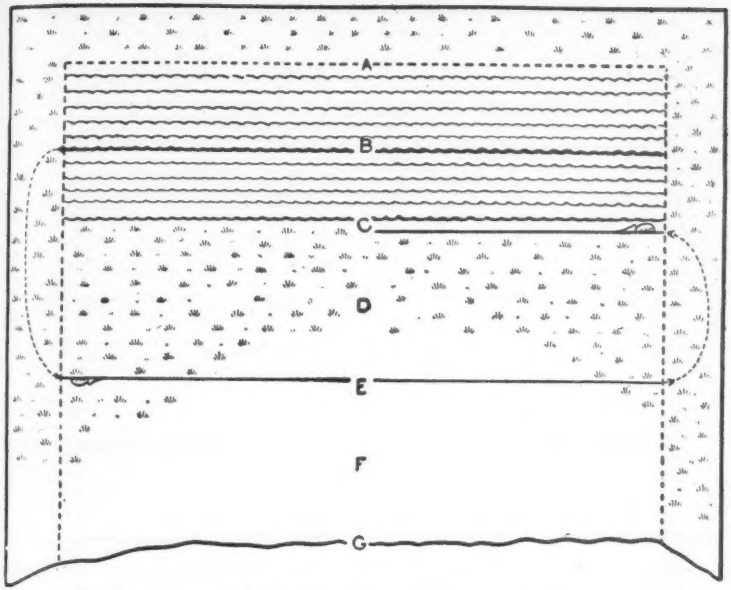

FIG. 4.—Method II, second stage: The first land has been completed in a dead furrow at B and a second land laid out at E, to be plowed around as shown. This is the field shown in figure 3.

If the headland is left clear around the field and plowed by turning to the right, there will also be a back furrow at A and a corresponding one on the other side of the field.

If the lands are made of the same width as in Method I there will be the same amount of idle running across the ends and the same number of short turns to make at the dead furrows as there are at the back furrows in Method I. Dead furrows will occur where back furrows were in Method I, and vice versa. On account of this, if a field that has been plowed according to Method I be plowed next time according to Method II there will be a tendency to smooth out the back furrows and dead furrows.

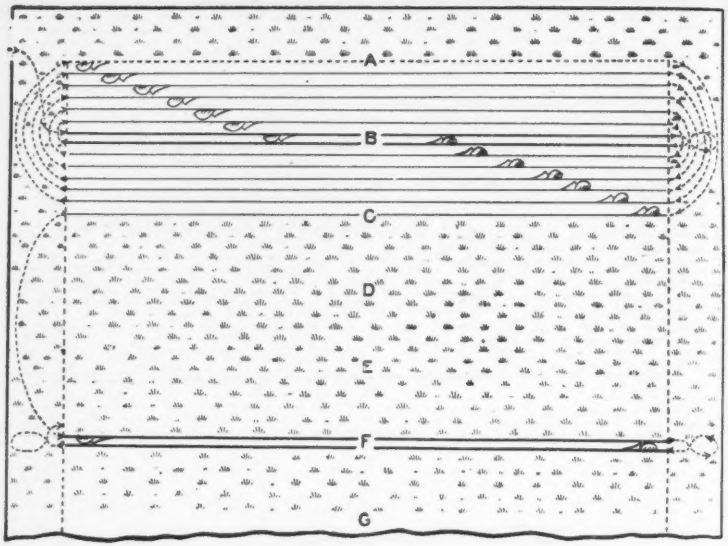

FIG. 5.—Method III, first stage: A new back furrow laid out at F after the land is completed around a back furrow at B, as in figures 1 and 2.

METHOD III.

This scheme is a combination of back furrow and dead furrow lands as described in Methods I and II, by which the number of back furrows and dead furrows can be reduced without any extra running with the plows idle and without increasing the number of short turns.

First, plow out a land around a back furrow through B (fig. 5), just as in Method I, but when this land is finished, instead of laying out another back furrow at D, go clear on over to F to lay out the next back furrow, making the distance from C to F three times the distance from A to B, which was taken in laying out the first back furrow.

Plow around this back furrow until the land is as wide as the distance from A to C; that is, until the lines E and G are reached, as in figure 6. Then the land from C to E, still to be plowed, will be of the same width as each of the two lands already plowed. This is to be plowed out by turning to the left from the furrow through E, as shown in figure 6, plowing down the line at C, where an open furrow was left when

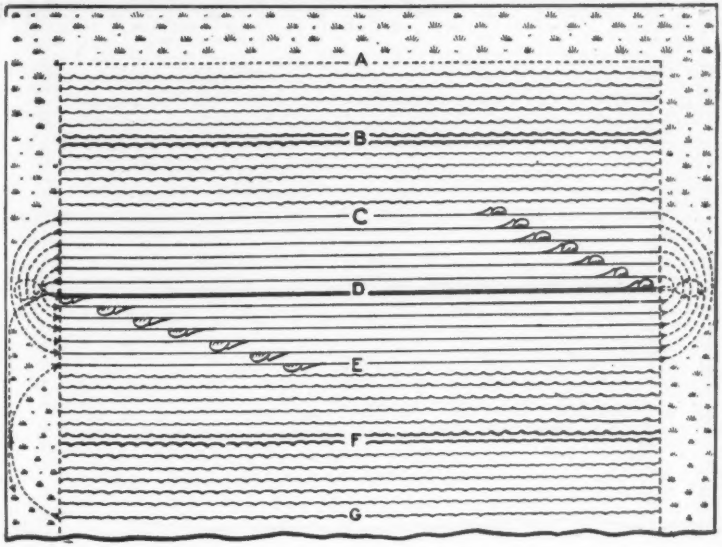

FIG. 6.—Method III, second stage: The field shown in figure 5 with the land from E to G completed around the back furrow F, and the land from C to E plowed around leaving a dead furrow at D.

the first land was finished, and finishing out the land to a dead furrow at D. There will then be a back furrow at B, a dead furrow at D, and another back furrow at F.

Next, measure a distance ahead from G equal to the distance from C to F (3 times that from A to B), lay out a back furrow along a line at this distance, plow around this until the land is the same width as those plowed around the back furrows at B and F, and then finish the strip between the edge of this land and the line through G (fig. 6) as a dead-furrow land, the same as the one between C and E was plowed.

If the lands are made of the same widths as in Methods I and II, there will be only half as many dead furrows and back furrows when this scheme is followed, but the number of short turns will remain the same. If it is desired to have as few dead furrows and back furrows as possible, and there is no great difficulty in making short turns with the outfit, this method should be very satisfactory. Any method which eliminates the short turns entirely must involve some extra travel across the ends with the plows idle.

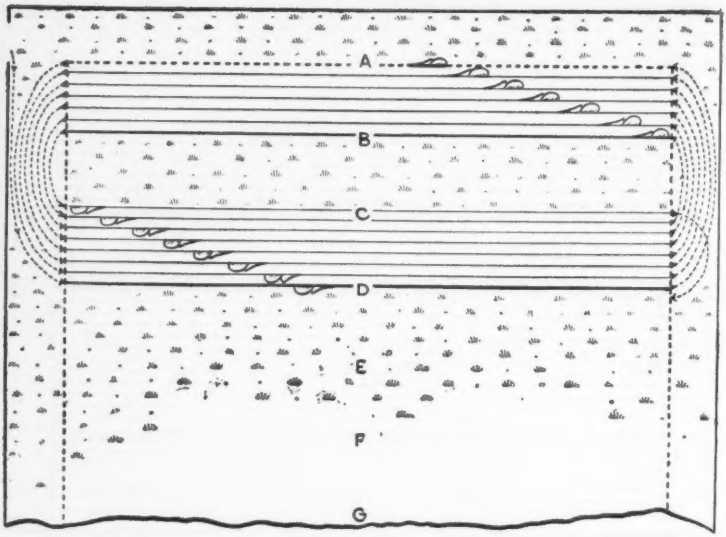

FIG. 7.—Method IV, first stage: To avoid the short turns in the methods previously described, the first furrow is struck at D, and left-hand turns are made until the space from B to C equals space from A to B.

METHOD IV.

This is one of the methods designed to avoid the short turns found at the dead furrows and back furrows in the schemes already described. Unless the lands are made narrower and the dead furrows and back furrows more frequent, there must be more traveling idle across the ends than in Method III. The plowman should consider whether the difficulties and loss of time at the short turns overbalance the objections to more numerous dead furrows and back furrows, or whether traveling a considerably greater distance with the plows idle will be preferable to the short turns.

Start the first land (see fig. 7) by plowing a furrow through D, going in the direction indicated, turn to the left and come back along the line of the headland through A, and continue to plow around this land, turning always to the left, as in Method II, until the two strips from A to B and C to D have been plowed. Then turn to the right about the strip from C to D, plow down the line through D, making a back furrow here, and continue plowing around this strip, always turning to the right as in figure 8, until the strip C to B is finished. There will then be a dead furrow at the line through B and an open furrow at E, which will be filled on the first round of the next land. In this next land there will be a dead furrow at F corresponding to the one in the first land at B.

In order to get an idea of the relative efficiency of this method, suppose that the strip from B to C is left of the same width as those from A to B and C to D, and that the distances between A, B, C, D, etc., in figures 7 and 8 are made the same as they were in figures 5 and 6 (Method III). The dead furrows and back furrows at B, D, F, etc., will then be at the same distance apart in one case as in the other.

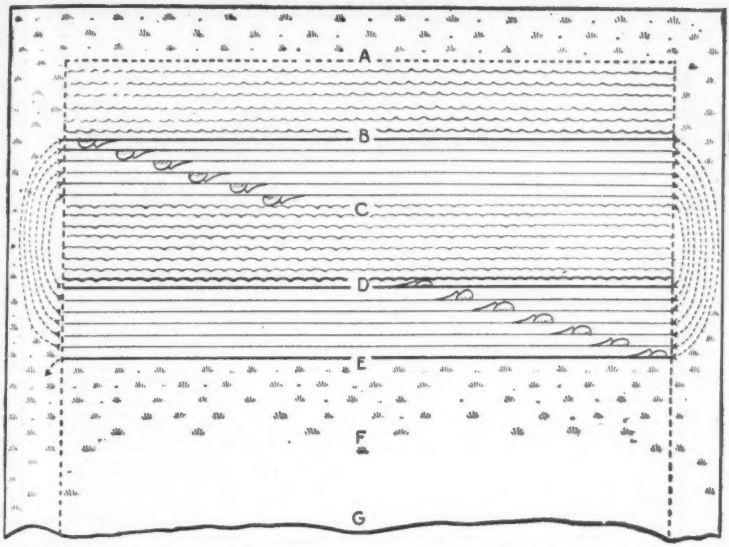

FIG. 8.—Method IV, second stage: Right-hand turns are made in plowing the strip B to C left, as shown in figure 7, and a dead furrow is left at B.

In plowing that part shown in figure 7, the crosswise distance from A to D, which is three times that from B to C, must be covered with the plows idle on the first round, and that from B to C on the last round. The average distance, then, of idle travel for each trip across the field in plowing the two strips A to B and C to D, equals twice the distance from B to C.

When the outfit starts turning to the right and plowing around the strip from C to D, as shown in figure 8, the distance of idle travel on the first round equals that from C to D, which we are assuming is the same as that from B to C, and the distance of idle travel on the last round is that from B to E, which is three times that from B to C. The average distance to be traveled with the plows idle in plowing this part, then, is twice that from B to C, the same as in plowing the first part of the scheme.

In plowing according to Method III the average crosswise distance traveled with the plows out of the ground is equal to that from B to C. If the back furrows and dead furrows are to be kept the same distance apart, the question which should decide between the two methods is, "Will doubling the total amount of travel with the plows idle be preferable to making a series of short turns at B, D, F, etc.?" In order to have the average distance between the points where the plows are lifted and where they enter the ground again the same in both cases, the distances between A, B, C, D, etc., will have to be made just half as great in Method IV as they are in Method III, and this, of course, will make the dead furrows and back furrows twice as numerous.

It is not necessary that the strip from B to C should be made of exactly the same width as those from A to B and C to D. It will be more convenient in measuring off the distances to have them all the same, but if turning to the right is preferred, it can be started as soon as the strip from C to D is wide enough to make it convenient. If turning to the left is preferred, plowing can be continued on the strips from A to B and C to D until the distance from B to C becomes too small to permit convenient turning. If the width of the strip from A to E to be plowed out in one combination

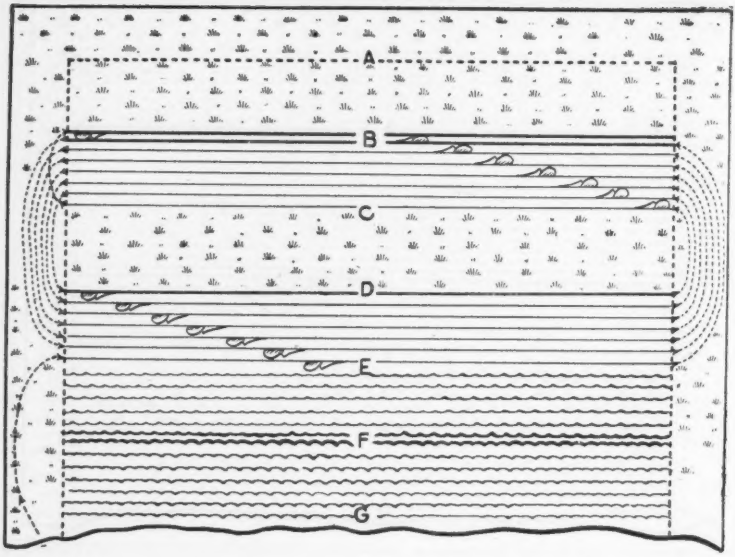

FIG. 9.—Method V, first stage: The first furrow is made through E, a long left-hand turn is made and a furrow plowed through B, continuing until the distance from C to D equals that from B to C. The finish is shown in figure 10.

be fixed beforehand, and the distance from D to E made greater if it is intended to start turning to the right as soon as the strip between C and D is wide enough to permit it, or made smaller, if it is intended to continue turning to the left, as long as the unplowed strip between B and C is wide enough to permit it, the total crosswise distance to be covered at the ends with the plows idle will always be constant and the same as if the distances between A, B, C, D, etc., were all equal. The back furrows and dead furrows, however, will not all be the same distance apart.

METHOD V.

This scheme is very similar to that described under Method IV, and if it is used on a field which has previously been plowed according to that method, it can be arranged so that the back furrows come where the dead furrows came before, and vice versa.

To start, plow along the line through E (see fig. 9), turn to the left and come back along the line through B, and continue to plow, always turning to the left, until the lines through C and D are reached. Turn to the right around the plowed strip between

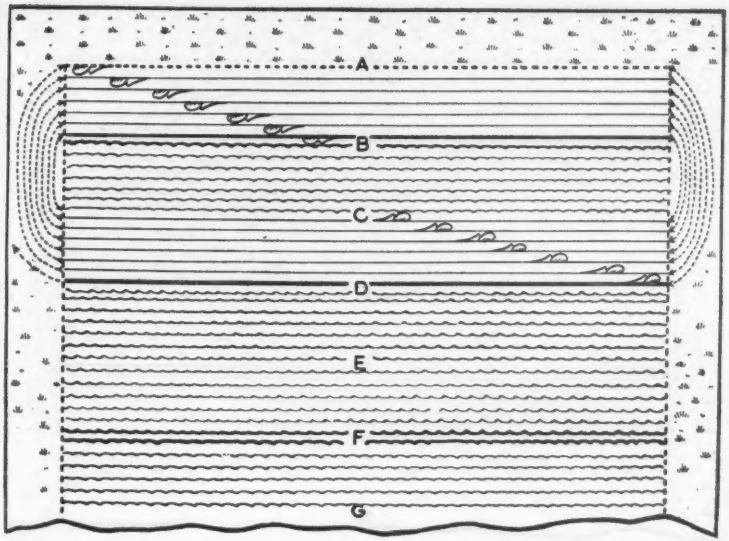

FIG. 10.—Method V, second stage: Right-hand turns are made around the plowed strip between B and C until D is reached, where there will be a dead furrow. There will be a back furrow at B and an open furrow at A.

B and C, making a back furrow at B, and continue to plow as indicated in figure 10, always turning to the right, until the strip between C and D is plowed out to a dead furrow at D. In method IV there was a dead furrow at B (see fig. 8), while in this method there is a back furrow at B (see fig. 10). In this method a dead furrow is left at D, while in the previous method there was a back furrow along this line.

In this method the plowing must be started on the side of the field opposite to that on which it was started in Method IV, so that an open furrow at E will be left at the finish of the preceding land, to be filled on the first trip across the field shown in figure 9.

The amount of idle travel will be the same in both methods if the widths of the lands are made the same. If the field has been previously plowed according to Method IV, and if the dead and back furrows are still visible, it may be possible to use them as guides in opening up the lands without measuring any distances at all.

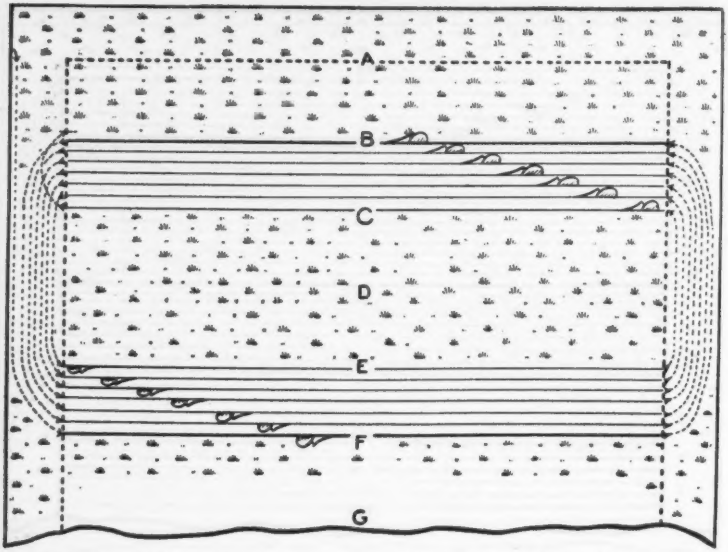

FIG. 11.—Method VI, first stage: The first furrow is plowed through F, a long left-hand turn is made to the line through B, and this round is continued until the strips B to C and E to F are finished. The next step is shown in figure 12.

METHOD VI.

This is a method by which the field is plowed in successive back-furrow lands (see Method I), but the short turns necessary at the beginning of each land, when the plowing is done according to Method I, are eliminated.

In laying out the field, measure off the distances from A to D and from D to G (fig. 11), making them the same and equal to the total width desired for each land. Then determine how wide a strip (between B and C) is necessary to permit convenient turning around it. Subtract this width from the distance between A and D, the total width of the land, and make the distance from A to B equal to one-half the remainder. Put F the same distance from G that A is from B.

Plow on the line through F as shown in figure 11, turn to the left, come back on the line through B, and continue to plow as indicated, always turning to the left until the strips between B and C and E and F are plowed. These strips form

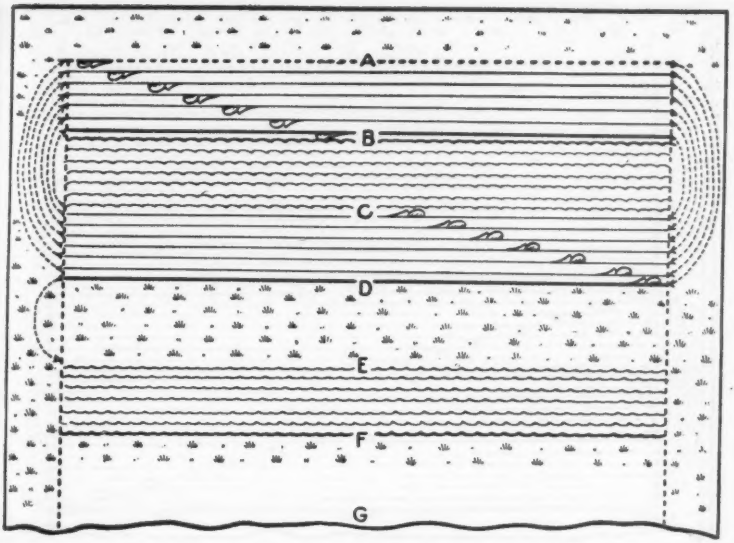

FIG. 12.—Method VI, second stage: Short turns are avoided by plowing around the plowed strip B to C. The finish is shown in figure 13.

the foundations for two back-furrow lands. Turn to the right, around the plowed strip between B and C, plow along the line through B, making a back furrow here, plow around this strip, always turning to the right until A and D are reached as indicated in figure 12. Next plow around the strip between E and F in the same manner as around the strip B to C, as indicated in figure 13, making a back furrow at F until D and G are reached, and the two lands finished. Then lay out two more lands, starting at G, and repeat until the field is finished.

There will be back furrows at B, F, etc., and dead furrows at D, G, etc. If the widths of the lands (A to D, D to G, etc.) are made the same here as they were in Method I (A to C, C to E, etc., in figures 1 and 2), there will be the same number of back furrows and dead furrows in one case as in the other, but they are not all the same distance apart in Method VI, the distance between D and F being greater than that from F to G in figure 12. The only other difference between the two methods is that the travel across the ends as shown in figure 11 is substituted for the short turns shown at the beginning of the lands in figures 1 and 2.

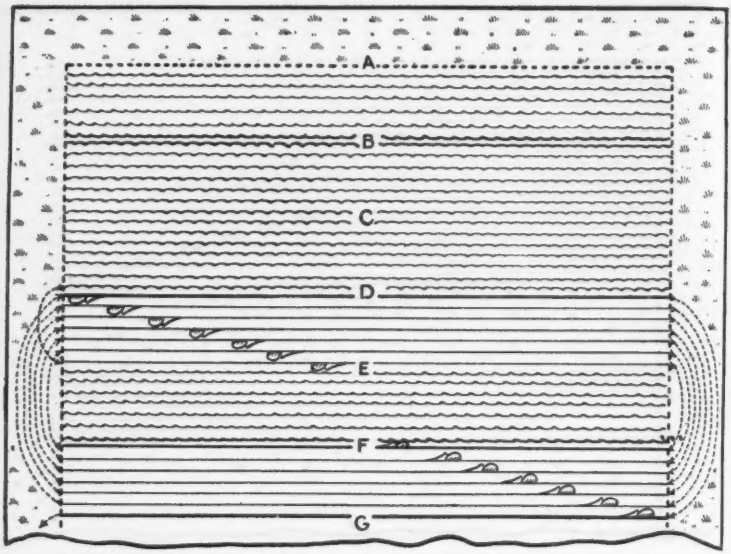

FIG. 13.—Method VI, third stage: Right-hand turns are made around the strip E to F until D is reached, forming a dead furrow. There are back furrows at B and F.

In choosing between the two methods, the farmer must decide whether this extra travel is preferable to the short turns. Needless to say, turning to the right and plowing around the strips between B and C and E and F should be begun as soon as they are wide enough to permit easy turning. With some outfits three, or possibly only two trips across the field along each strip will be sufficient.

These strips might be plowed in a direction opposite to that shown in figure 11, by starting along the line through C, turning to the right, coming back along the line through E and continuing, always turning to the right, until B and F were reached. The final result would be the same except that the back furrows would be at C and E, instead of at B and F.

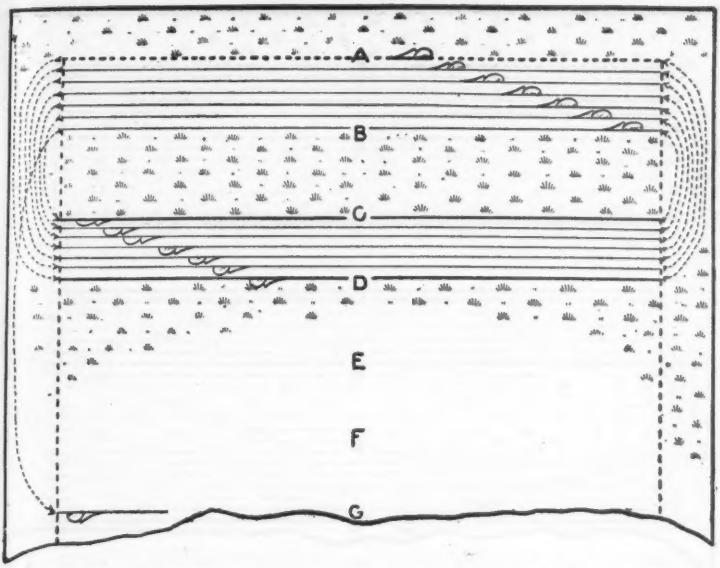

FIG. 14.—Method VII, first stage: A field plowed by successive dead-furrow lands. The first furrow is plowed through D, a long left-hand turn is made through A, and this plan is continued until B and C are reached. The next step is shown in figure 15.

METHOD VII.

This is a method by which the field is plowed out in successive dead-furrow lands, but the short turns necessary at the finish of each land when plowing according to Method II are eliminated. As in Method VI, rather long runs across the ends, with the plows idle, are substituted for these short turns.

To open up the field, measure off the distance from A to D, which is to be the entire width of the first land; plow along the line through D, as indicated in figure 14, turn to the left and come back along the line of the headland at A. Continue plowing around this land, always turning to the left, until the unplowed strip between B and C becomes too narrow to permit of easy turning at the ends. Then lay off the distance from D to G, making it the same as that from A to D; plow around this land, as indicated in figure 15, in the same manner in which the first land was plowed, until the strip between E and F is plowed down to the same width as the strip between B and C, left in the first land. These two strips are now to be plowed out together by going clear across the ends from the furrow through F to the line through B as indicated in figure 16. Continue to plow on the two strips as indicated there, until they are finished, leaving dead furrows at E and C.

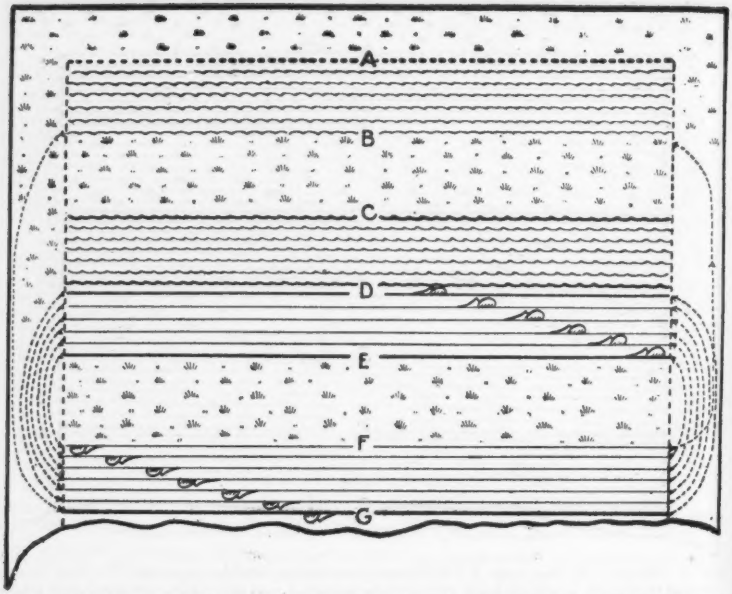

FIG. 15.—Method VII, second stage: A furrow is plowed through G, a long left-hand turn is made to the line through D, and this plowing is continued until the strip E to F is of the same width as the one from B to C. The finish is shown in figure 16.

Two other lands are then to be laid off below G the same width as these and plowed out in the same way, and so on until the other side of the field is reached. There will be back furrows at D, G, etc., dead furrows at C and E, and at corresponding points in the other lands. If the headland is plowed out by turning to the right and throwing the furrow away from the fence, there will also be back furrows at the line through A and at the corresponding line on the other side of the field.

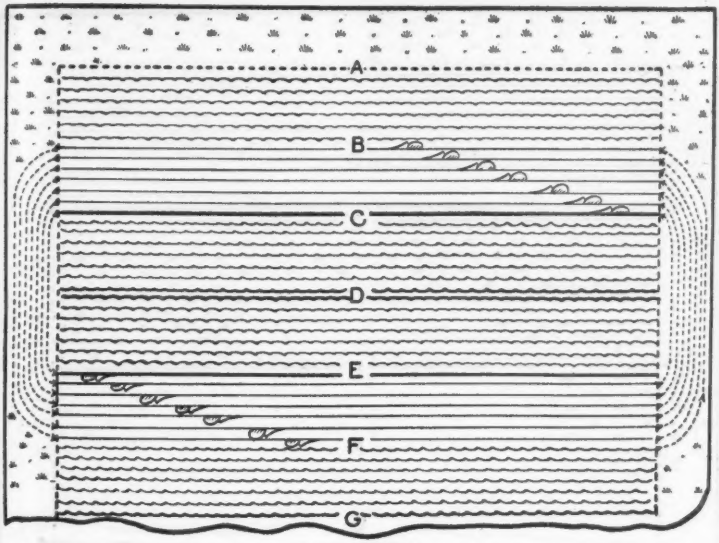

FIG. 16.—Method VII, third stage: The strips B to C and E to F are plowed by making long left-hand turns.

The direction of travel in plowing out the middles of the lands might be reversed, in which case the dead furrows would be at the points F and B. If this were done, it is seen that the dead furrows in this method will all come along the lines where there were back furrows in Method VI (see fig. 13), and vice versa. If a field which has been plowed according to either of these methods be plowed according to the other method the next time, there will be a tendency to smooth out all the dead furrows and back furrows. There will be the same amount of idle running across the ends in this method as in Method VI, provided, of course, the lands are given the same width in each case. The plowman must decide for himself whether the added amount of idle running across the end in plowing out the middle of the lands is preferable to the short turns necessary when one of the schemes described under Method I and II is followed.

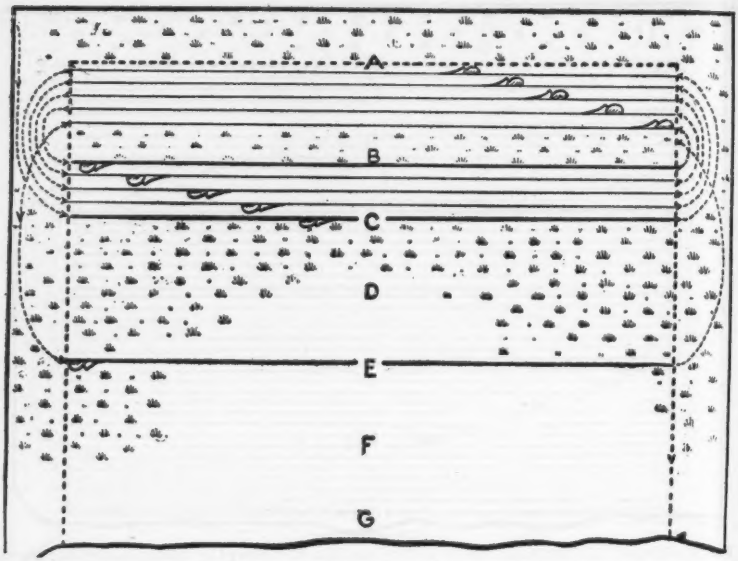

FIG. 17.—Method VIII, first stage: Start with a furrow through C, plow the return furrow through A, and plow around this strip until the remaining strip is too narrow to permit of convenient turning. The next step is shown in figure 18.

METHOD VIII.

This is another method designed to eliminate the short turns. Probably it is somewhat simpler than the two methods described.

Measure the distance from A to C (fig. 17), which is to be the entire width of the first land. Plow around this land, turning to the left as indicated in the diagram until the strip at the center is too narrow to permit of convenient turning at the ends. Thus far the procedure is the same as in plowing the first land in the preceding method (the one between A and D in figure 14). Now measure the distance from C to E, making it approximately the same as that from A to C, and finish plowing out the first land by turning to the left, as indicated in figure 18. When this land is plowed out to the dead furrow at B, start plowing on the line through C, making a back furrow here. Continue plowing on this land between C and E in the same manner that the land between A and C was plowed until the center becomes too narrow to permit a turn. Then measure the distance E to G and finish plowing out the middle at D, in conjunction with the start of the new land at G, and so on across the field. There will then be back furrows at C, E, G, etc., and dead furrows at B, D, F, etc.

If the width of the lands, i. e., from A to C and from C to E, is made the same as in Method II (figs. 3 and 4), there will be the same number of dead furrows as in that method, but the dead furrows will not be exactly in the middle of the lands. The travel across the ends with the plows idle, in finishing each land, equal to that shown in figure 18, from the line through B to that through E, is substituted for the short

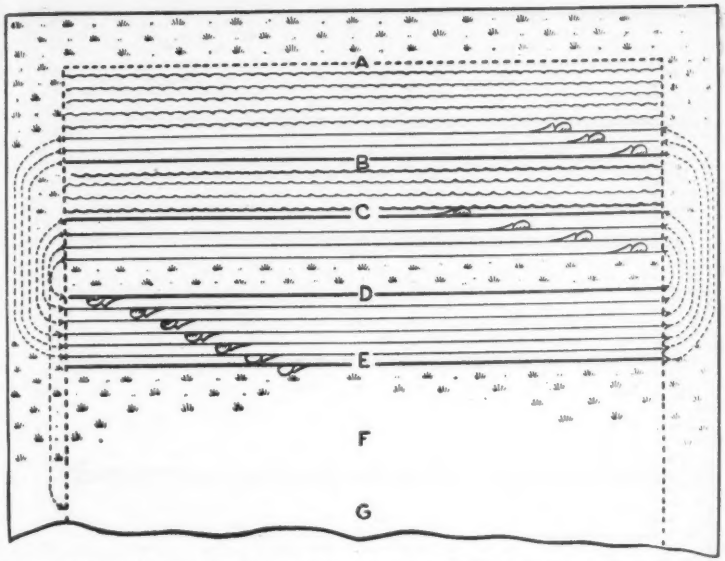

FIG. 18.—Method VIII, second stage: A furrow is plowed through E, and left-hand turns are made until the narrow strip is finished, when a furrow is plowed through C, and this plan continued till the unplowed strip between C and D becomes too narrow to make a convenient turn.

turns necessary in Method II. The question in deciding between the two methods is whether this extra travel is preferable to the short turns in finishing the lands. It is apparent that the wider the strip left in the middle the greater will be the amount of idle travel necessary to finish it.

In comparing this method with Method VII, it is seen that there will be the same number of back furrows and dead furrows in the field if the lands are made of the same width in each case, but there is no complementary method which stands in the same relation to Method VIII that Method VI does to Method VII, by which the dead furrows and back furrows can be smoothed out at alternate plowings.

The amount of idle travel necessary to plow out the middles of the lands is somewhat greater in this method than in method VII. The distance from B to E in figure 18 must be traversed for each trip across the field, while only a distance corresponding to that from B to D would be necessary in finishing the lands if method VII were used. On the other hand, not so much care in getting the distances all exactly the same is necessary here, for it makes little difference if the strips which are left to be plowed out in connection with the beginning of the succeeding lands are not all exactly of the same width.

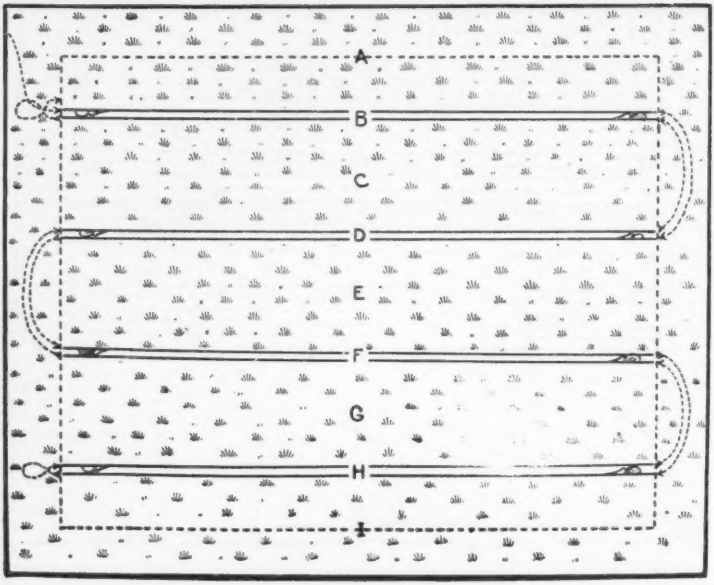

FIG. 19.—Method IX, first stage: All back furrows are laid out first by plowing the first furrow through B, back through D, then through F and H, and reversing the course to the beginning. The next step is indicated in figure 20.

METHOD IX.

By this method the field is plowed in successive back-furrow lands, but the short turns at the beginning are eliminated by laying out the whole field at one time and starting all the lands by proceeding from one back furrow to the other as indicated in figure 19.

When the positions for all the back furrows at B, D, F, H, etc., have been determined, start the plowing along the line through B, as indicated, turn to the right, come back along the line through D, then turn to the left and plow along through F and so on, making one trip across the field along the line of each back furrow until the last one is reached, as at H. The direction of travel is then reversed, and the back furrows all completed by plowing along the same lines until the point where the first back furrow was started is reached. A single short turn must be made at the last back furrow at H. If one trip in each direction across the field does not plow a strip wide enough to turn around easily, the procedure can be repeated as many times as may be necessary. Each land is then plowed out separately by continually turning to the right, about the back furrows at B, D, etc., as is shown in figure 20.

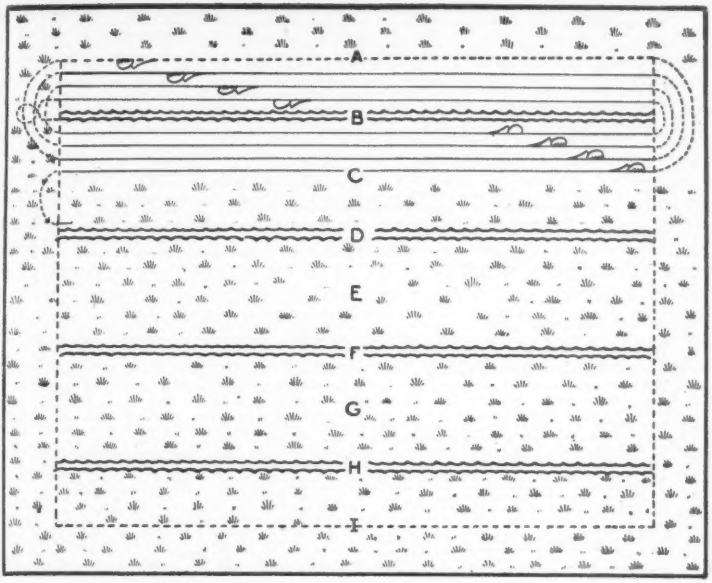

FIG. 20.—Method IX, second stage: The back furrows B, D, F, and H were laid out as in figure 19, and each land is plowed by turning to the right about these back furrows.

The net result is the same as if the field had been plowed according to Method I. The position of the back furrows has already been pointed out, and there are dead furrows at C, E, and G.

The extra travel across the ends in laying out the dead furrows, which amounts to practically twice the width of the field, if only one round is plowed at each one, as is indicated in figure 19, must be balanced against the short turns which are necessary if one back furrow is laid out at a time, in determining the advisability of using the scheme. The whole field must be staked out before plowing is begun and care taken to have all distances exact, so that there will not be a narrow strip left unplowed at I or G when the last land is finished.

A scheme similar to the one shown in figure 19 could be used for finishing the body of a field which is being plowed in successive dead-furrow lands. Each land can be plowed down until the strip at the middle is too narrow to turn on, and all these strips finished at once, just as the lands are started in figure 19, except, of course, that the direction of travel is reversed and each one plowed out to a dead furrow.

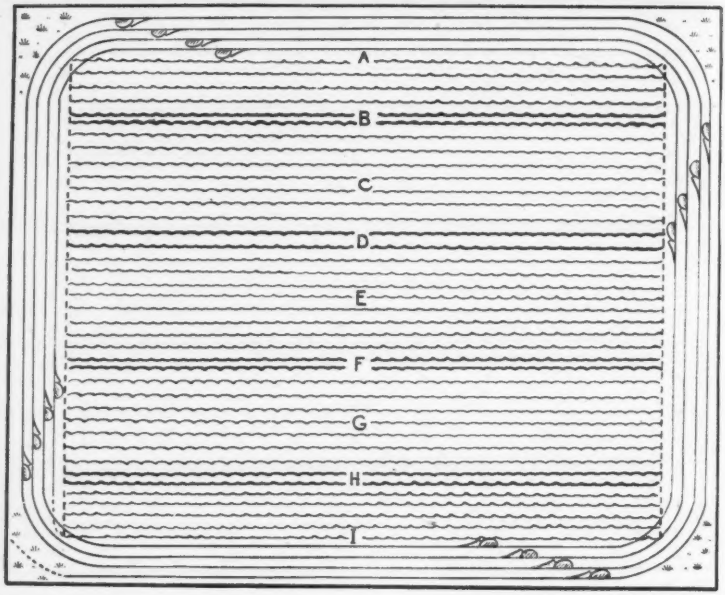

FIG. 21.—Plowing the headland. This is done by plowing around the field, "cutting" the corners enough to insure easy turns, throwing the furrows toward the plowed lands.

PLOWING THE HEADLAND.

If a headland has been left on all four sides of the field, as in figure 21, it can be plowed by going around the body of the field as indicated, cutting into the plowed ground at the corners enough on the first round to make the turns without leaving any ground unplowed.

The headland can be plowed (1) by turning to the right and throwing the furrow away from the fence as indicated; (2) by going in the opposite direction, turning to the left and throwing the furrow toward the fence; (3) by doing a part of it in the manner shown in the figure and then reversing the direction, throwing toward the fence and leaving a dead furrow all the way around the field in the middle of the headland; or (4) in a manner just the reverse of this, with a back furrow in the middle all the way around the field

If the body of the field is plowed so that open furrows are left at A and I, these will be filled on the first round if the headland is plowed in the manner first described and there will be no dead furrows or back furrows near the edges of the field. When the lands adjacent to the sides of the field are plowed by turning to the left, there will be back furrows at A and I.

If the headland is plowed in the second manner, there will be dead furrows at A and I, when the body of the field is plowed according to any of the methods which

leave open furrows at A and I. If the body of the field is plowed according to method II or any other method whereby the first furrows at A and I are thrown upon the unplowed land, an open furrow will be left along each of these lines when the headland is plowed by turning to the left throughout and throwing the furrow toward the fence. The careful plowman will try to avoid turning the earth away from the fence, or vice versa, in successive plowings, and the direction in which the headland is to be plowed should have some consideration in laying out and plowing the body of the field.

A triangular piece will be left in each corner of the field which can not be plowed with the tractor unless the outfit is very easily handled and can be turned very short or backed easily in order to get the plows up into the corners. The amount which must be cut off the corners of the plowed ground on the first turn around the headland will depend on the turning radius of the tractor, and this in turn will determine the size of the unplowed pieces left in the corners of the finish. Changing the point of hitch of the plows will often enable one to plow closer to the fence than would otherwise be possible. If the headland is plowed by turning to the right, possibly the plow can be hitched further to the left on the tractor, and one of the rear wheels run on the plowed ground the last turn around the field.

When the body of the field is plowed clear out to the fence on each side and headlands left only across the ends, they must be plowed as described under Method I or II (p. 8), according as a back furrow or dead furrow is desired. In this case a rectangular piece, usually somewhat larger than the triangular pieces in the corners in figure 21, will be left in each corner of the field.

If it is intended to use horses to finish the corners, it will not pay to spend too much time in trying to get those corners as small as possible with the tractor. It may also pay to plow the last furrow or two near the fence with the horses rather than to spend time in changing the hitch of the plow or in going clear around the field to turn a strip narrower than the total width of the plows.

METHODS IN WHICH PLOWS ARE LEFT IN THE GROUND IN GOING ACROSS THE ENDS.

The objections to the methods already described are that they necessitate a considerable amount of travel with the plows idle, and that there are many dead furrows and back furrows if an attempt is made to reduce the amount of this idle running. As before stated (see p. 5), the use of any of these methods usually results in a somewhat better job of plowing than the methods involving an attempt to keep the plows in the ground all the time the tractor is moving; but many farmers think that the possible reduction in quality of the work is not sufficient to offset the saving of time effected by eliminating the idle running.

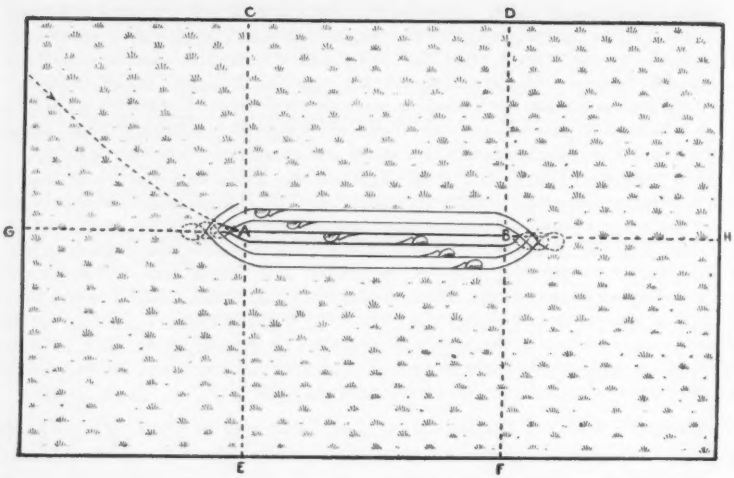

FIG. 22.—Method X, first stage: To begin plowing in the center of the field, a back furrow A—B is laid out in the center of the field, the distance from A to C equal to that from A to E. The continuation of this plan is shown in figure 23.

METHOD X.

By Method X a rectangular field is plowed around a single back furrow at the middle of the field. The plows are lifted only in making the comparatively few short turns on the first few trips across the field. After the plowed land becomes wide enough for the outfit to turn around the ends, the plows are never lifted from the ground until the field is finished.

The position and length of the back furrow (from A to B in fig. 22) at the center of the field is determined in much the same manner as is often done in laying out a field for back furrow plowing with horses. Make the distance from A to C equal to that from A to E, and make the distance from A to G enough shorter so that when the land is rounded off at the ends and plowing clear around the land is begun, as indicated in figure 23, the furrow across the end will be the same distance from the edge of the field as are the furrows down the sides. Make the distances from B to D and B to F the same as those from A to C and A to E, and make that from B to H equal to that from A to G.

On the first few trips across the field, pull the outfit over to the right every time as the end is approached, so as to get the corners rounded off as soon as possible sufficiently to permit the outfit to make the turn without lifting the plows. Lift the plows and make a complete circle to the left in turning. The number of times the plows will

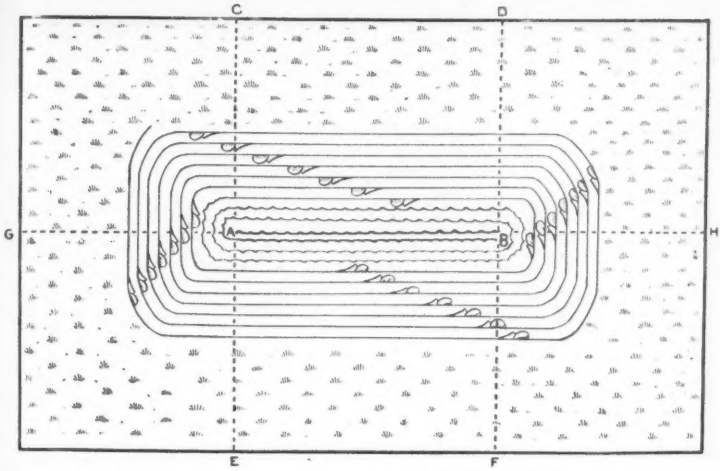

FIG. 23.—Method X, second stage: Plowing around the central back furrow started in figure 22 until the field is finished.

have to be lifted at the ends and the outfit turned to the left in order to get the ends in shape to go around with the plows in the ground will depend mostly on the turning radius of the outfit and the width of the strip plowed at each trip. For some large, cumbersome outfits the land may have to be 75 feet or even more in width before this can be done, while a small outfit with a short turning radius may be able to turn about a strip half as wide.

Some care will be necessary in steering the tractor at the turns after the land becomes wide enough to permit leaving the plows in the ground continuously, as in figure 23, if the turns are to be kept abrupt. The shorter the turns are kept the smaller will be the triangular pieces left in the corners of the field at the finish. However, if the tractor runs with one or two of the wheels in the furrow, it may be preferable to let the corners round off as they will and take more time in plowing out the corners with the horses.

If the field is square, or nearly so, it can be plowed in two or more lands, each one laid out according to this method. In such a case extra pieces, each approximately twice as large as the unplowed pieces at the corners, will be left at the ends of the field between the lands.

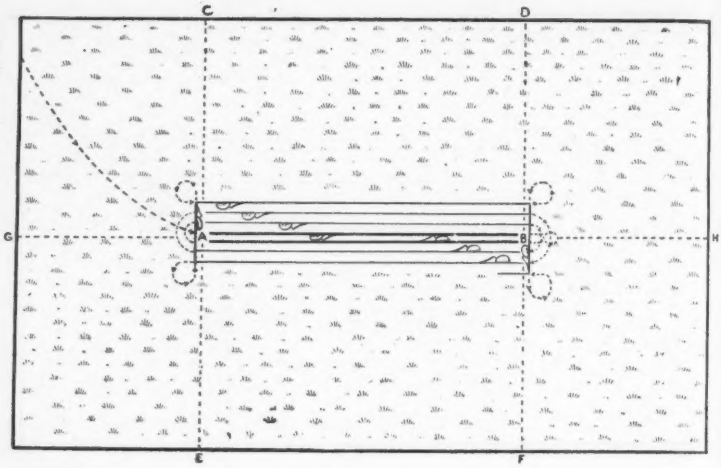

FIG. 24.—Method XI, first stage: Plowing a field in one land by starting a back furrow in the center of the field, the same as in figure 22. The corners are kept square by making short turns to the left and swinging around so as to plow across the ends. The continuation of this plan is shown in figure 25.

METHOD XI.

In plowing by Method XI a rectangular field is laid out, just as in the preceding method, and the entire field plowed in one land about a single back furrow.

In a field such as that shown in figure 24, the distances should be measured exactly as was shown in figure 22, the distances from A to G and B to H being somewhat less than those from A to C, B to D, etc., so that when plowing across the ends is begun the end furrows will be at the same distance from the fence as the side furrows. The back furrow is laid out along the line from A to B and the plows lifted at the ends on the first few rounds, as indicated in figure 24, until the land is wide enough to warrant plowing across the ends. Then, as the plows are lifted the outfit is turned sharply to the left and brought around as indicated by the dotted lines at the corners in figure 24, so that it will be in line for plowing across the end when the plows reach the place where the furrows should begin. The corners are kept square by turning in this way (see fig. 25) until the furrows get so near the fence that not enough room is left to make such a turn. Then the corners must be rounded and the tractor turned to the right.

Since this scheme keeps the corners square, except for the last few rounds, approximately the same amount of ground should be left unplowed in the corners of the field as there is in plowing the head-

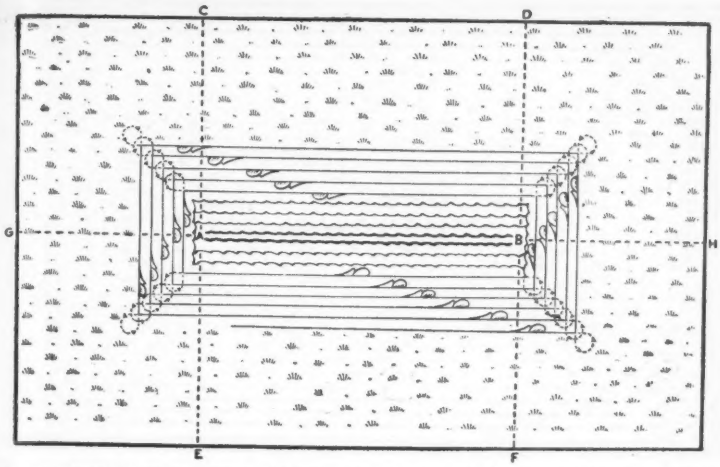

FIG. 25.—Method XI, second stage: A field plowed around a central back furrow, with square corners and furrows across the ends. This is the continuation of the plan shown in figure 24.

land around a field, the body of which has been plowed by running with the plows idle across the ends. (See fig. 21.)

Except for these last few rounds, the net result of plowing a field by this method is the same as is ordinarily attained by plowing a back-furrow land with horses. The greatest objection is probably the time and travel necessary to make the turn to the left at each corner. This travel at each corner will amount to just about a complete circle. For a tractor with a 20-foot turning radius, this means something over a hundred feet of travel. Many large tractors pulling several plows have a considerably greater turning radius than this. Thus the loss of time in many cases would be too great for this method to be advisable.

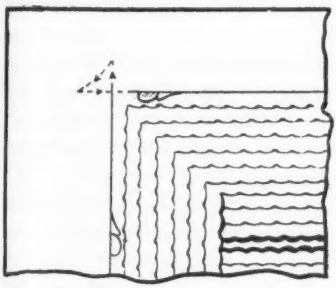

FIG. 26.—Method XI, corner turns: The square turns shown in figure 25 are made by backing around the corners on a triangle.

If the plows are hitched to the tractor in such a way that the machine can be backed easily, the turns can be made by backing it around through a quarter of a circle, as indicated in figure 26, with a comparatively small loss of time. Such an outfit can make these turns until the field is practically finished.

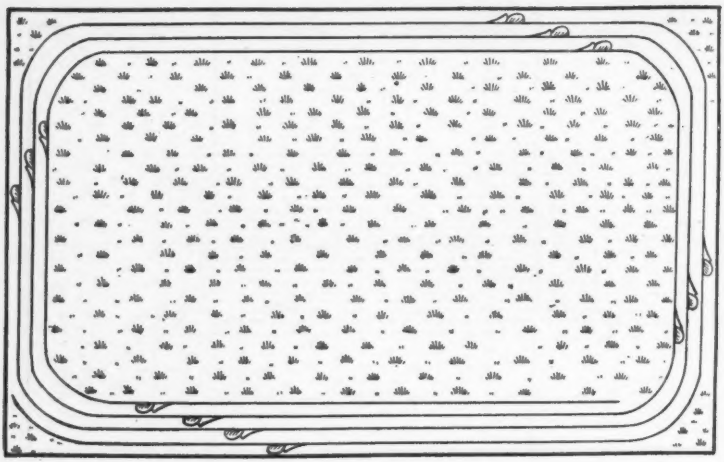

FIG. 27.—Method XII, first stage: Plowing around a rectangular field by turning the furrows toward the fence, rounding the corners enough to permit turning without lifting the plows.

METHOD XII.

In this method the operator starts plowing at the outside of the field, as shown in figure 27, throwing the furrow toward the fence and turning to the left at the corners without lifting the plow. A rectangular field like that shown is plowed in a single land with one dead furrow. The corners will have to be rounded to a certain extent on the first trip around the field, and kept this way throughout the plowing so as to permit the tractor to make the turns without encroaching too far on the plowed ground or getting the furrows irregular and crooked near the corners. The plows will be pulled away from the last open furrow to a certain extent in making the turns and the diagonal strips running from the ends of the dead furrow to the corners of the field will usually have to be replowed. (See figs. 28 and 29.)

It is not necessary to measure any distances when this scheme of plowing is followed, and this will save some time over any of the schemes heretofore described. On the first round the plows can often be set over to the right and the ground turned nearer the fence than is possible in the two preceding back-furrow methods. The plows are left in the ground from the time the field is entered until the dead furrow at the center is reached. This feature makes the method desirable if the plow is not equipped with a power lift. A field with slightly irregular or crooked boundaries can be plowed by

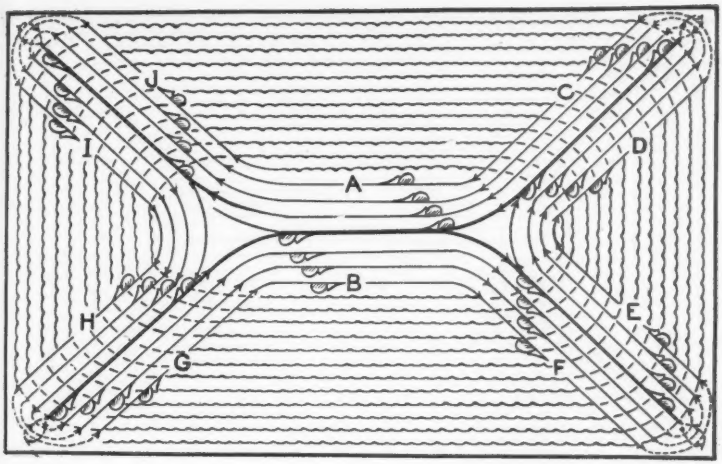

FIG. 28.—Method XII, final stage: Plan for plowing the diagonal strips which are left imperfectly plowed at the turning points, leaving dead furrows at the finish.

following this scheme, practically as good a job being possible with no more effort than in a rectangular field. This method is very popular with men who have tractors pulling five or more plows, and has been adopted almost exclusively where disk plows are used.

The body of the field can be plowed clear out to the dead furrow and the diagonal strips running in from the corners replowed one at a time or left to be plowed with horses, but when this is done the tractor must pull out on to the plowed ground to turn, as the dead furrow is approached and the unplowed land becomes narrow. Also it must travel over the plowed ground, making the turns at the center of the field when plowing the diagonals. Unless horses are to be used for this, one of the schemes shown in figures 28 and 29, by which the diagonals are plowed out at the same time the dead furrow is finished, will usually be preferable.

By the scheme shown in figure 28, a dead furrow is left along each diagonal, and by the scheme shown in figure 29, a back furrow is made along the middle of the diagonals, with open furrows on each side. If the first-mentioned scheme is to be employed, when the distance from A to B (in fig. 28) becomes the same as that from C to D, E to F, etc., the width to be replowed along the diagonals, turn to the right from the line through A, plow along the line through J to the corner of the field, turn

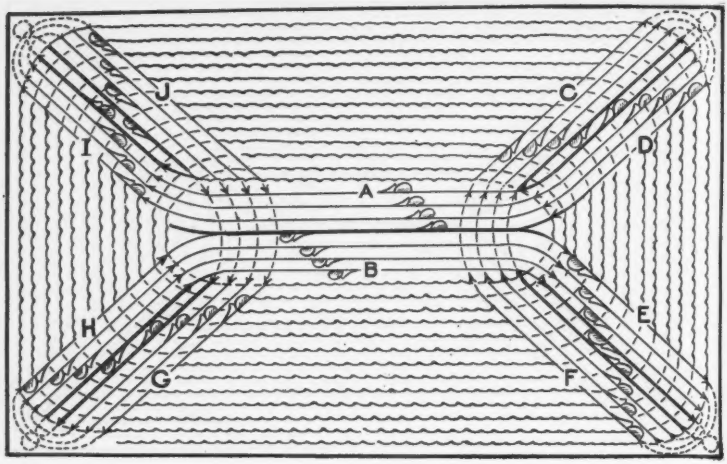

FIG. 29.—Method XII, final stage: Another plan for plowing the diagonal strips which are left at the turning points in figure 27, leaving a back furrow in these and a dead furrow in the center.

and come back along the line through I, turn to the left when the unplowed land at the center is reached, plow out along the line through H, and back through G. When the unplowed land at the center is reached, turn to the right, plow along the open furrow through B until the other diagonal is reached. Then turn to the right and plow along the lines through F, E, D, and C, in turn, in exactly the same manner as at the other end of the field. Plow back along the open furrow at A to the other end and follow the same course around the diagonals and along the strip through the center of the field, as indicated in the figure, until the diagonals and the center are finished. The tractor will have to do very little traveling over the plowed ground, and if care is taken to get all the distances exact, the whole field, with the exception of the parts left for making the short turns at the corners, can be finished at the same time. The only times the plows are lifted in plowing the whole field are on the few short turns at the corners in plowing the diagonals.

If it is desired to have back furrows along the diagonals instead of dead furrows, the method of procedure will be as shown in figure 29. It is similar to that shown in figure 28, except that the back furrows are thrown up on the first trips along the diagonals. The turn is to the right at the corner of the field each time, the plows are taken out of the ground in going between the two diagonals at the same end of the field, and the outfit will have to travel over the plowed ground a little more at these points.

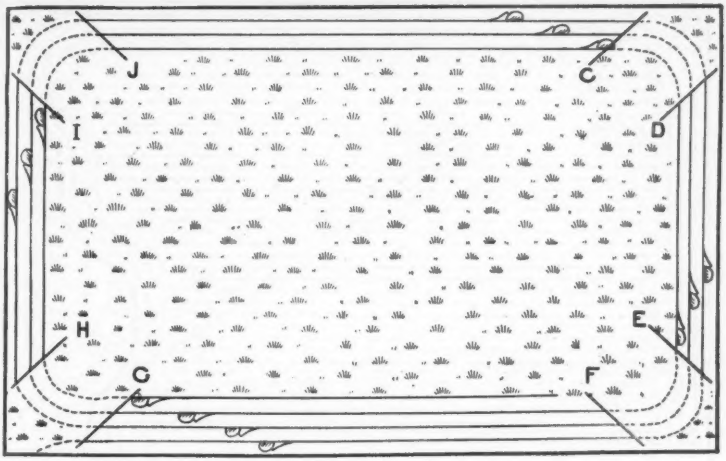

FIG. 30.—Method XIII. Plowing around a rectangular field as in method XII. The plows are lifted at the turns, as shown by the dotted lines.

METHOD XIII.

This is like the preceding method except that the plows are lifted each time at the corners in plowing the body of the field, and the diagonals are left entirely unplowed until the finish of the field. Care must be taken to get the width of all the diagonals, i. e., from C to D, E to F, etc., in figure 30, the same if either of the methods shown in figures 28 and 29 is to be used in finishing the field. The width should be ample for turning the outfit and getting it in line with the furrow, before the point where the plows are to be put into the ground again is reached. It will be better to make an extra round in plowing out the diagonals than to be cramped for space at every turn in plowing the body of the field. If the plow is equipped with a power lift, very little time will be lost in using this method, and the travel over the partially plowed ground, with the attendant difficulties of steering and rough riding in plowing the diagonals at the finish of the field, will be obviated.

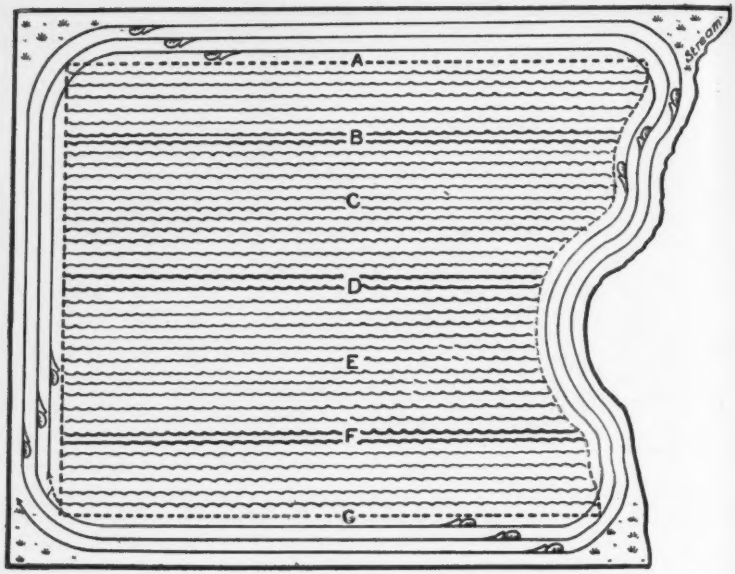

FIG. 31.—Plan for plowing a field having one irregular side.

IRREGULAR FIELDS.

Irregular fields have such a variety of shapes and present such a variety of conditions that it is impossible to give any definite directions applicable to all. If the field is comparatively level, and the irregularities are confined to the boundaries on one or two sides, some one of the methods described for rectangular fields can usually be adapted to laying it out for the plow.

Figure 31 illustrates a field with the irregularity confined to a stream which forms the boundary at one end. Usually such a field can be plowed satisfactorily by one of the methods where the plows are taken out of the ground in going across the end, as is shown in the figure. The procedure will be the same as in a rectangular field except in laying out the headland across the end adjacent to the stream. There the line for lifting the plows and letting them into the ground must be made parallel to the stream if the field is to be finished without undue loss of time in plowing the headland along the stream. If the headland is plowed by turning to the left so that the first round will take in the irregularities along the stream, it will probably be less difficult to finish it satisfactorily than if it is plowed by turning to the right, as shown in the figure.

If the irregularity is simply due to a road, railroad, or a farm boundary which is a straight line but does not run at right angles to the other boundary lines that join it, the problem of laying out and plowing the headland will be little, if any, more difficult than in a rectangular field.

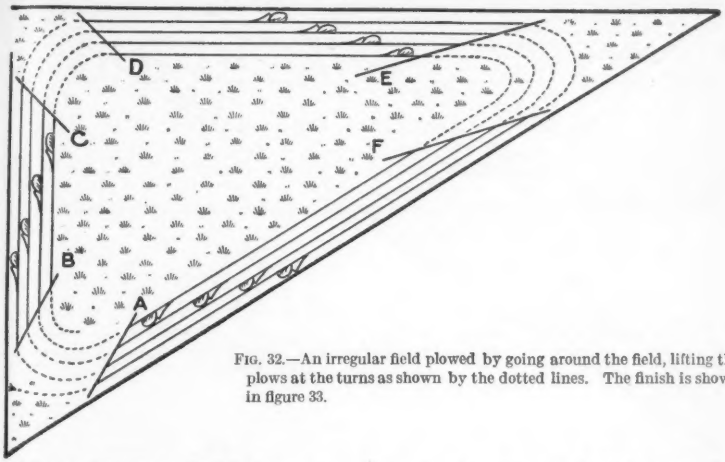

FIG. 32.—An irregular field plowed by going around the field, lifting the plows at the turns as shown by the dotted lines. The finish is shown in figure 33.

Method XII or XIII (see page 34) can often be used satisfactorily for plowing such fields. If the irregularity is along one or both ends, but the sides of the field still straight and parallel, the irregularity will entirely disappear before the dead furrow is reached.

A good method of plowing a triangular field is shown in figures 32 and 33. This is really a variation of Method XIII, described on page 37. The body of the field is plowed by starting next to the fence, going round and round the field, turning always to the left, and lifting the plows at the corners. The distances from A to B, C to D, and E to F, in figure 32, should all be made the same, and should be great enough to permit easy turning at the most acute angle of the field. That is, in a field such as that shown, the distance from E to F, which must be left for the sharp turn at this corner, should determine the distances from A to B and C to D. When the body of the field is finished, there will be three strips, all the same width, one extending into the center of the field from each corner, left to be plowed in the manner indicated in figure 33. It may not be possible to finish completely the center of the field where the three strips come together, but if care is taken on the last few turns around the body of the field, and not quite a full furrow taken at the narrow end, so as to make the furrows as nearly parallel as possible, very little need be left there to be finished with horses. Of necessity more ground will be left unplowed by the tractor in the sharp corners than would be the case if only a right-angle turn were necessary.

A four-sided field which has one of the long sides not parallel to the other can be laid out into two parts, one a rectangular plat and the other a triangular plat as illustrated here. The rectangular part can be plowed in any desired manner and the triangular part as here described.

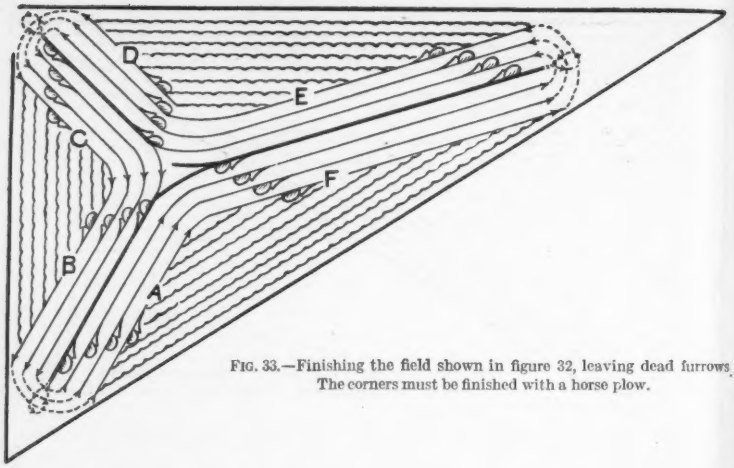

FIG. 33.—Finishing the field shown in figure 32, leaving dead furrows. The corners must be finished with a horse plow.

If a field which would otherwise be rectangular has had a square or rectangular piece taken off one corner for a feed lot, orchard, part of the farmstead, or the like, it will usually be better to treat it as two separate fields in laying it out, with the imaginary dividing line between the two an extension of the line of the lot or orchard, which is parallel to the longest side of the field.

When the character of the field is such that its contour must be taken into account, the best method of plowing will depend always on the peculiarities of the field, and it would be useless to attempt to give any general directions.

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LAYING OUT FIELDS FOR TRACTOR PLOWING

TRACTOR PLOWING usually requires methods of laying out the land different from those followed when plowing with horses and an ordinary plow.

Farmers plowing with a tractor for the first time are often at a loss for the most satisfactory method of laying out their fields.

A scheme admirably suited to one size and type of tractor under certain field conditions may not be satisfactory for some other size and type under different conditions.

This bulletin embodies descriptions of the more common methods recommended by farmers who plow with tractors.

Among these will be found methods of laying out land suited to nearly every farm and to fields of different shapes.

Washington, D. C.

Issued May, 1919
Revised June, 1926

LAYING OUT FIELDS FOR TRACTOR PLOWING

By C. D. KINSMAN, *Agricultural Engineer, Bureau of Public Roads,* and L. A. REYNOLDSON, *Associate Economic Analyist, Bureau of Agricultural Economics*

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FACTORS TO BE CONSIDERED IN MAKING PLANS FOR TRACTOR PLOWING

FARMERS who plow with tractors desire to do a high-class job of plowing over the entire field and to reduce to a minimum the time spent in turning and in traveling with plows out of the ground. To accomplish this they must choose the method which is best suited to their conditions. Many circumstances must be considered in deciding just what method is best for a particular field with a particular outfit. Every job presents a problem of its own, and there is no one method which is best for all cases.

The two classes of laying out fields for plowing include those methods in which the plows are lifted out of the ground in crossing the ends and those where they are not lifted. The advantages of the first class are that short turns are eliminated, except in some cases at the beginning and ending of the lands and it is generally possible to do a little higher quality of plowing at the corners or turns. The advantages of the second class are that little or no time is lost in traveling with the plows out of the ground, and that ordinarily the number of deadfurrows and backfurrows will be considerably less.

Time spent in turning or running with the plows lifted reduces the acreage which can be plowed in a day; on the other hand, the making of short turns is awkward with some tractors, particularly the larger ones, and the operator often has difficulty in getting the outfit in the correct position for starting the furrow when such turns are made. Though it may pay to make some additional effort to avoid short turns when using a large outfit, it should be borne in mind that the loss in time and fuel due to making long idle runs across the ends of the field is just as serious with the large outfit

as it is with the small, easily handled tractor. From the standpoint of time lost in idle running, the size of the outfit should be considered only with reference to the relative difficulty in making short turns.

In deciding the method to use, the ease of handling the tractor and plows is not always necessarily the most important thing to consider. In regions of heavy rainfall, it may be best to make narrow lands with frequent deadfurrows and backfurrows as an aid to drainage; in more arid regions the reverse may be true. In other cases the contour of the ground or the shape of the field may be such as to determine almost entirely the method that must be followed.

If the field is rectangular and level, or nearly enough so that the irregularities do not have to be considered, the choice between a method of the first class and one of the second class will usually depend on how hard it is to handle the tractor and plows in making short turns and how objectionable are additional backfurrows and deadfurrows. To keep their fields level, some farmers choose one method one year and alternate with some other method the following year.

METHODS IN WHICH PLOWS ARE LIFTED AT THE ENDS

If it is decided that a method of the first class in which the plows will be out of the ground in going across the ends of the field is to be used, it must then be decided into how many lands the field should be divided for best results, how wide to leave the headlands on which to turn, and where to set the guide stakes or markers.

WIDTH AND NUMBER OF LANDS

The wider the lands are made the fewer will be the deadfurrows and backfurrows, but the greater will be the time consumed in idle running across the ends. Some idea of the distance traveled with the plows out of the ground can be obtained by considering a specific case. Suppose a field 40 rods wide is to be plowed in this manner, one land at a time, and that it is laid off into five lands of 132 feet each. If the tractor is pulling three 14-inch plows, it will take about 37 trips across the field to plow out each land. If we ignore the extra distances that the tractor must cover in swinging out of the furrow and back into it again, and in making the short or figure-eight turns in starting a backfurrow land or finishing a deadfurrow, the average length of travel across the ends—that is, the average distance in a straight line from where the plows are taken out of the ground to where they enter it again—is half the width of the land, or 66 feet. This makes 2,442 feet, or almost a half mile for each land, and almost 2½ miles of idle travel in plowing the entire field. If the field were laid out into 11 lands, each 60 feet wide, the total unproductive travel would be about 1 mile; if the field were laid out in only 3 lands, it would be about 4 miles.

The longer time necessary to make the difficult turns at each backfurrow or deadfurrow, which must be added to the time to travel these straight-line distances, will reduce the advantage of the narrow lands in this respect to a certain degree; but ordinarily a 3-plow tractor, which has a comparatively short turning radius, and

with which the making of short turns does not take a great deal of time, will plow a strip 40 rods wide laid out in five lands in about an hour's less time than if it were laid out in three lands. A 2-plow tractor will have to make one and one-half times as many trips across the field to plow a strip of a given width, and consequently the time lost in idle running will be about 50 per cent greater than with a 3-plow outfit. A 4-plow outfit will have to make only half as many trips as the 2-plow outfit, and so will lose only half as much time.

The length of the field is also of importance in deciding the width of the land, since the time lost in turning on a short field for a given width of land is much greater in proportion to the total time required to plow it than is the case with a long field. For this reason a wider land is usually selected when the field is long than for short fields.

Each farmer must decide for himself whether the saving in time in making narrow lands is sufficient to offset the disadvantages of the extra deadfurrows and backfurrows and any difficulties of making short turns. The most popular width under average conditions seems to be about 100 feet for a 2 or 3 bottom plow. However, if the field has no irregularities, its entire width should be measured and divided into lands of approximately equal width.

HEADLANDS

If the field is fenced on all sides, it will usually be better to leave an unplowed strip of uniform width entirely around the field, to be finished after the body of the field is plowed out, than to have the lands extend to the fences on the sides. A headland extending entirely around the field can be plowed by going repeatedly around the field until it is finished, thus eliminating short, awkward turns.

If one end of the field is unfenced and the outfit can be pulled out into a road or lane or an adjoining field for turning, it may be preferable to plow up to the fences on the two sides, as the body of the field is being plowed, and leave only the one headland across the end of the field which is fenced. Such a headland may be plowed later with either a deadfurrow or backfurrow through the center.

The width of the headland will depend largely on the turning radius of the tractor with attached plows. Some farmers with very easily-handled outfits do not leave more than 10 to 15 feet; however, any extra ground in the headland can be plowed just as quickly as if it were plowed with the body of the field, and plenty of room should always be left to allow easy turning and to get the outfit headed in exactly the right direction on entering the furrows. Also the wider the headland, the less is the tendency to go over the same ground repeatedly in turning at the ends and seriously packing it when plowing out the body of the field. Headlands 20 to 40 feet in width for small tractors and even as much as 100 feet for large tractors will usually be preferable to very narrow ones. With most tractors, the width of the headlands should be at least twice as great as the length of the outfit with the plows attached.

Many farmers plow across the field along the line of each headland, throwing the furrow toward the center of the field, before starting on the body of the field. This gives a good guide for lifting the plows and letting them into the ground again at the ends and leaves a much more uniform headland. The plows will also enter the ground more quickly when starting the furrow at the end, if a guide line has been plowed.

SETTING STAKES AND MARKERS

If the field is to be finished up in the best manner, with no irregular unplowed strips between the lands or at the edges, it is essential that care be taken to have the headland of the same width all around

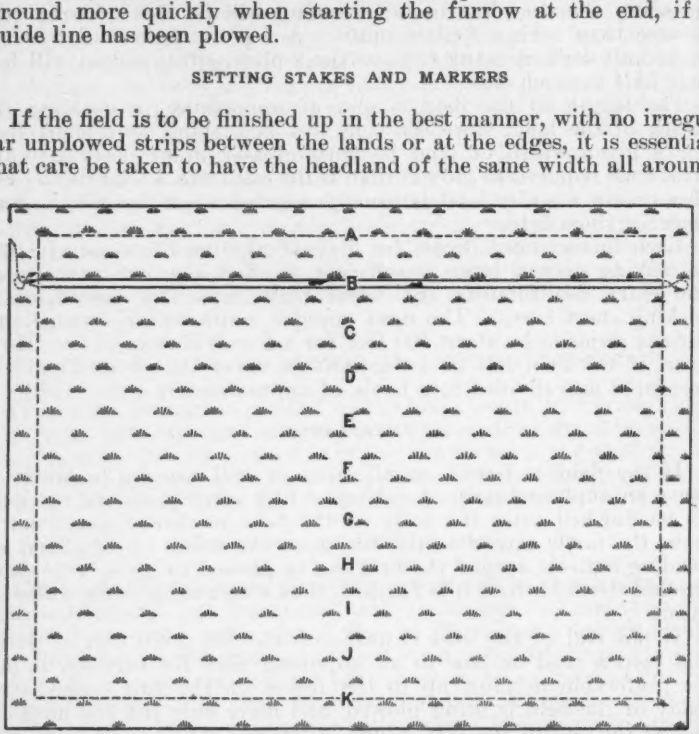

FIG. 1.—Method I, first stage: A headland all around the field, the body of the field to be plowed in successive backfurrow and deadfurrow lands. Note the loops made at the ends on the first round to avoid short turns. The symbols representing plows show the direction of travel

the field, to have the distances carefully measured when starting new lands, and to have the first furrows as nearly straight as possible. A little extra time taken in measuring all the necessary distances and setting plenty of stakes for guides will usually be more than offset later by the time saved in plowing.

Most farmers prefer to "step off" the distances for setting stakes rather than use any more precise measure, and, as far as accuracy is concerned, this method of measurement will usually be satisfactory.

METHOD I

This is perhaps the most popular method of those in which the plows are kept out of the ground in crossing the ends of the field and its use also results in the least amount of travel with the plows lifted

for a given number of deadfurrows. By this method the body of the field is plowed in successive backfurrow and deadfurrow lands beginning at one side of the field and finishing at the other.

The first step in this, as in all methods where the plows are lifted at the ends, is to measure off and stake out the distance to be left for a headland, as indicated by the dotted line around the field in Figure 1. The width of the body of the land inside this dotted line should then be measured and the number and width of the lands decided upon. An odd number of lands should always be selected as there should be one less deadfurrow land than of those with a backfurrow.

The distance *AB*, half the width of the proposed lands, is then measured off and a backfurrow made at *B* as shown in Figure 1. Plowing is continued around this backfurrow until the line *A* is reached and the land from *A* to *C* is finished. Next measure off the distance *CF* equal to three times the distance *AB* and lay out another backfurrow at *F* as shown in Figure 2.

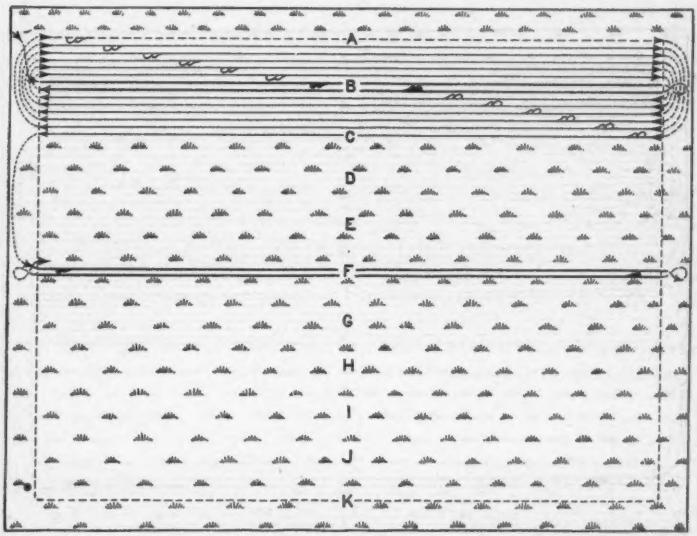

FIG. 2.—Method I, second stage: A new backfurrow is laid out at *F* after the land, is completed around a backfurrow at *B*, as in Figure 1

Plow around this backfurrow until the plowed land is as wide as the distance from *A* to *C*; that is, until the lines *E* and *G* are reached, as in Figure 3. Then the land from *C* to *E*, still to be plowed, will be of the same width as each of the two lands already plowed. This is then plowed by turning to the left from the furrow through *E*, as shown in Figure 3, plowing down the line at *C*, where an open furrow was left when the first land was finished, and finishing out the land to a deadfurrow at *D*. There will then be a backfurrow at *B*, and another backfurrow at *F*.

The ground between *G* and *K* is next measured off and plowed in the same manner as that between *C* and *G*, and this process is repeated until the entire body of the field is completed.

To illustrate by example, let us suppose that it is desired to plow a field with a width of 900 feet in lands as nearly 100 feet wide as is possible and that a space 30 feet wide is to be left around the field to be finished as a headland. The body of the field will then be 840 feet wide. Since there should be an odd number of lands,

either seven or nine may be selected. If the number of lands is seven, each land will be 120 feet wide and there will be three with deadfurrows and four with backfurrows; if the number of lands is nine, each land will be 93 feet, 4 inches wide and there will be four with deadfurrows and five with backfurrows. In the first case the distance *AB* would be 60 feet; in the second case it would be 46 feet 8 inches.

If Method I is used continuously year after year the backfurrows will in time form ridges and the deadfurrows will form ditches of considerable size. This can be prevented to some extent by varying the width of lands and headlands each time the field is plowed. A better way to prevent the formation of these ridges and ditches is to alternate Method I with Method II, or with some method of the second class.

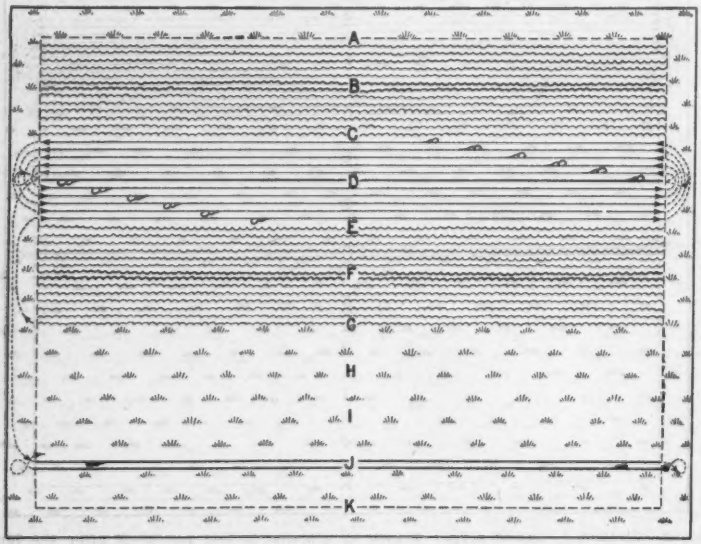

FIG. 3.—Method I, third stage: The field shown in Figure 2 with the land from *E* to *G* completed around the backfurrow *F*. The land from *C* to *E* plowed out, leaving a deadfurrow at D, and a new backfurrow started at *J*

METHOD II

This method consists of laying out the field exactly as in Method I with the exception that a backfurrow land is plowed in place of each deadfurrow land and a deadfurrow land in place of each backfurrow land.

The distance *AD*, Figure 4, is first measured off equal to one and a half times the selected width of lands and a backfurrow land is plowed starting at *D*. (*D* is the location of the deadfurrow formed when plowing the year previously by Method I.) The plowing of this backfurrow land is continued until its width is equal to *CE*. (This is the width of the deadfurrow land plowed the year previously by Method I.) A deadfurrow land is then started around the area *AC*, Figure 5, and continued until this land is completely

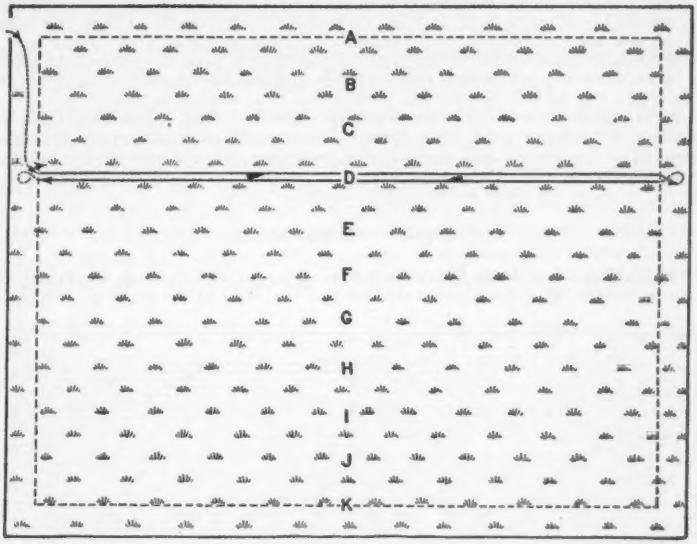

FIG. 4.—Method II, first stage: This method consists in laying out the field as in Method I, except that a backfurrow is plowed in place of each deadfurrow and a deadfurrow in place of each backfurrow. The first backfurrow is started at *D* instead of at *B* as in Method I

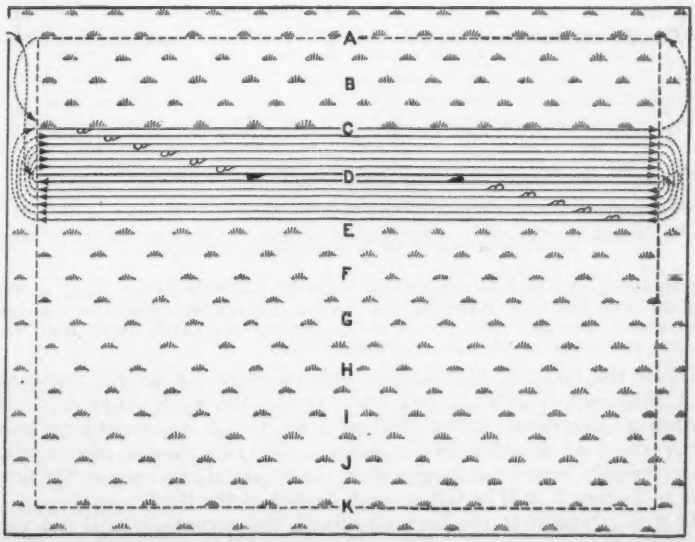

FIG. 5.—Method II, second stage: When the width of the backfurrow land around *D* is equal to *CE*, a deadfurrow land is then started around the area *AE*

plowed. (A deadfurrow will result at *B* where a backfurrow was formed the year previously by Method I.)

A second backfurrow land is next started at *H*, Figure 6. (*H* is the location of the second deadfurrow formed the year previously by Method I.) The process is repeated until the body of the field is plowed. Obviously there will be an even number of deadfurrow lands and an odd number of backfurrow lands when the field is completely plowed by this second method.

Several innovations to the two methods just described have been used to obviate short turns. They all require a greater amount of travel with the plows out of the ground and since the majority of tractors now on the market are so designed that reasonably short turns can be made with very little difficulty it does not seem necessary to describe them.

PLOWING THE HEADLAND

If a headland has been left on all four sides of the field as in Figure 7, it can be plowed by going around the body of the field to the right as indicated

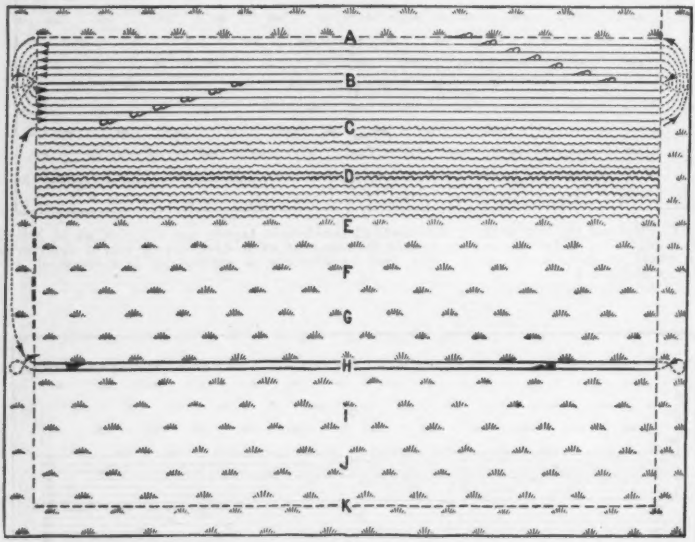

FIG. 6.—Method II, third stage: A new backfurrow land is started at *H* after the deadfurrow land around *AE* is completed as in Figure 3

and throwing the furrow toward the body of the field or by going in the opposite direction and throwing the furrow toward the fence or outside. The careful plowman will try to avoid turning the earth away from the fence or vice versa, in successive plowings.

When the body of the field is plowed clear out to the fence on each side and headlands left only across the ends, they may be plowed as described under Method I or II (p. 4), according as a backfurrow or deadfurrow is desired. In this case a rectangular piece, usually somewhat larger than the triangular pieces in the corners in Figure 7, will be left in each corner of the field.

If it is intended to use horses to finish the corners, it will not pay to spend too much time in trying to get these corners as small as possible with the tractor. It may also pay to plow the last furrow or two near the fence with the horses rather than to spend time in

changing the hitch of the plow or in going clear around the field to turn a strip narrower than the total width of the plows.

METHODS IN WHICH PLOWS ARE LEFT IN THE GROUND IN GOING ACROSS THE ENDS

The objections to the methods already described are that they necessitate a considerable amount of travel with the plows idle, and that there are many deadfurrows and backfurrows if an attempt is made to reduce the amount of this idle running. As before stated (see p. 1), the use of any of these methods usually results in a somewhat better job of plowing than the methods involving an attempt to keep the plows in the ground all the time the tractor is moving; but many farmers think that the possible reduction in quality of

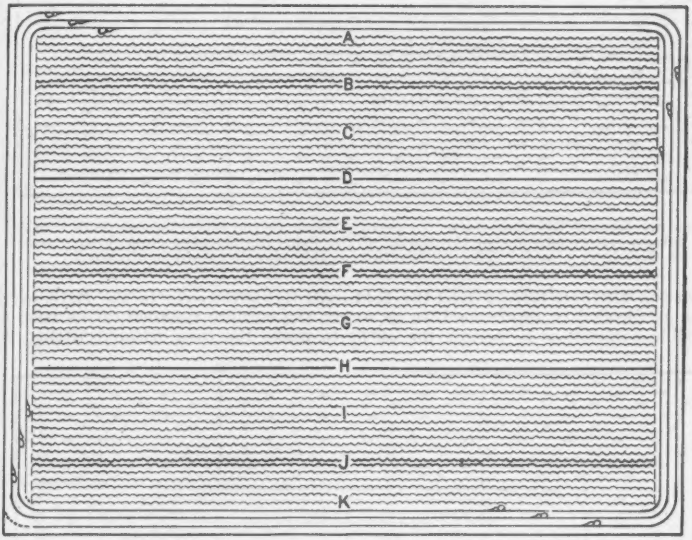

FIG. 7.—Plowing the headland. This is done by plowing around the field, cutting the corners sufficiently to insure easy turns, throwing the furrows toward the plowed land

the work is not sufficient to offset the saving of time effected by eliminating the idle running.

METHOD III

By Method III a rectangular field is plowed around a single backfurrow at the middle of the field. The plows are lifted only in making the comparatively few short turns on the first few trips across the field. After the plowed land becomes wide enough for the outfit to turn around the ends, the plows are never lifted from the ground until the field is finished.

The position and length of the backfurrow (from *A* to *B* in Figure 8) at the center of the field is determined in much the same manner as is often done in laying out a field for backfurrow plowing with horses. Make the distance from *A* to *G* enough shorter than from *A* to *C* so that when the land is rounded

off at the ends and plowing entirely around the land is begun, as indicated in Figure 9, the furrow across the end will be the same distance from the edge of the field as are the furrows down the sides. The point *B* should be the same distance from the end of the field as *A*.

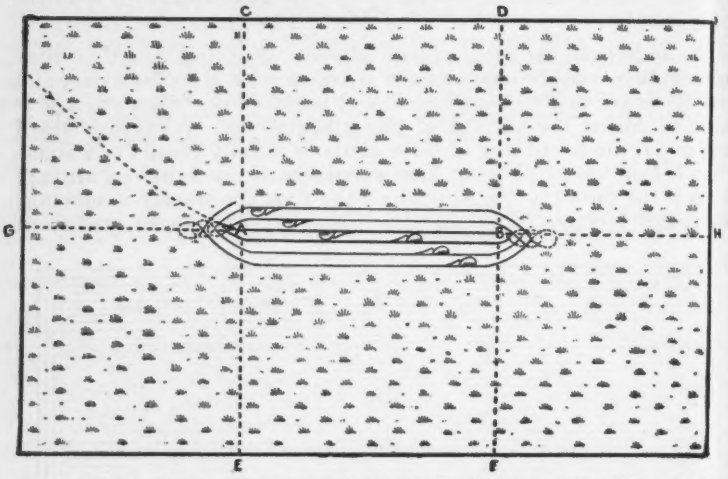

FIG. 8.—Method III, first stage: To begin plowing in the center of the field, a backfurrow *AB* is laid out in the center of the field, the distance from *A* to *C* equal to that from *A* to *E*. The continuation of this plan is shown in Figure 9

On the first few trips across the field, pull the outfit over to the right every time as the end is approached, so as to get the corners rounded off as soon as possible sufficiently to permit the outfit to make the turn without lifting the

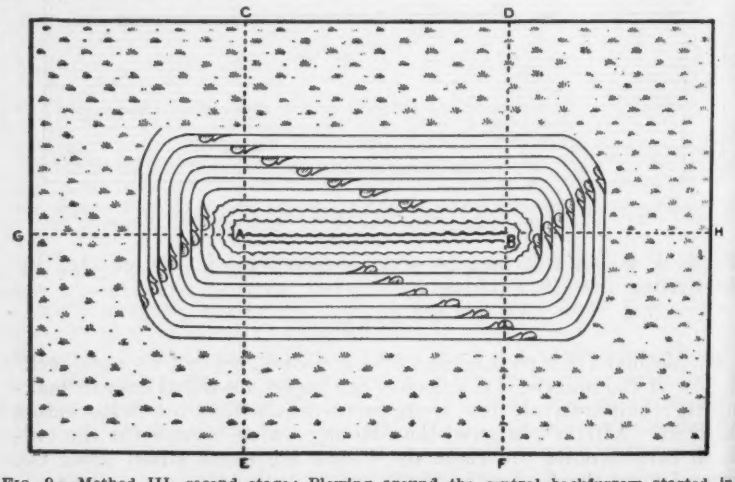

FIG. 9.—Method III, second stage: Plowing around the central backfurrow started in Figure 8 until the field is finished

plows. Lift the plows and make a complete circle to the left in turning. The number of times the plows will have to be lifted at the ends and the outfit turned to the left in order to get the ends in shape to go around with the plows

in the ground will depend mostly on the turning radius of the outfit and the width of the strip plowed at each trip. For some large outfits the land may have to be 75 feet or even more in width before this can be done, while a small outfit with a short turning radius may be able to turn about a strip half as wide.

Some care will be necessary in steering the tractor at the turns after the land becomes wide enough to permit leaving the plows in the ground continuously, as in Figure 9, if the turns are to be kept abrupt. The shorter the turns are kept the smaller will be the triangular pieces left in the corners of the field at the finish. However, if the tractor runs with one or two of the wheels in the furrow, it may be preferable to let the corners round off as they will and finish with horses later.

If the field is square, or nearly so, it can be plowed in two or more lands, each one laid out according to this method. In such a case extra pieces, each approximately twice as large as the unplowed

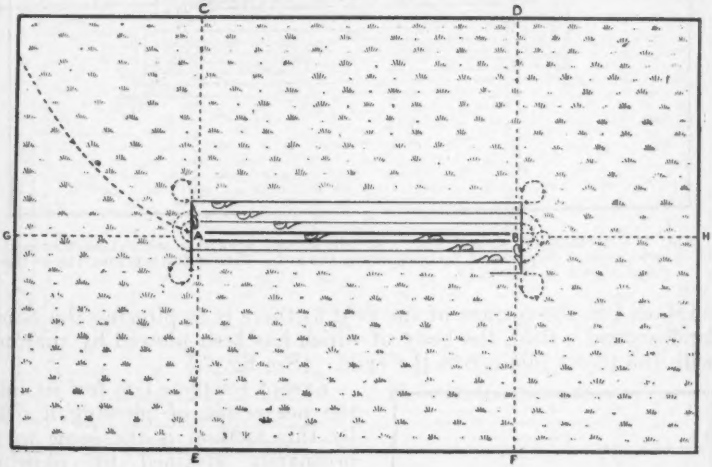

FIG. 10.—Method IV, first stage: Plowing a field in one land by starting a backfurrow in the center of the field, the same as in Figure 8. The corners are kept square by making short turns to the left and swinging around so as to plow across the ends. The continuation of this plan is shown in Figure 11

pieces at the corners, will be left at the ends of the field between the lands.

METHOD IV

In plowing by Method IV a rectangular field is laid out, just as in the preceding method, and the entire field plowed in one land about a single backfurrow.

In a field such as that shown in Figure 10, the distances should be measured as was shown in Figure 8. The backfurrow is laid out along the line from *A* to *B* and the plows lifted at the ends on the first few rounds, as indicated in Figure 10, until the land is wide enough to warrant plowing across the ends. Then, as the plows are lifted the outfit is turned sharply to the left and brought around as indicated by the dotted lines at the corners in Figure 10, so that it will be in line for plowing across the end when the plows reach the place

where the furrows should begin. The corners are kept square by turning in this way (see fig. 11) until the furrows get so near the fence that not enough room is left to make such a turn. Then the corners must be rounded and the tractor turned to the right.

Since this scheme keeps the corners square, except for the last few rounds, approximately the same amount of ground will be left

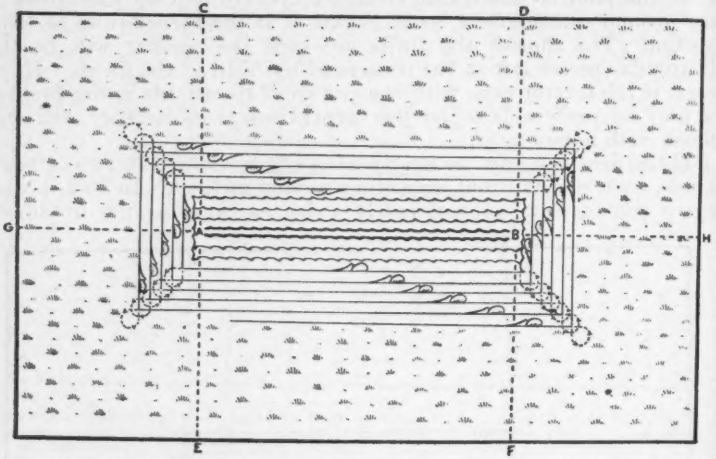

FIG. 11.—Method IV, second stage: A field plowed around a central backfurrow, with square corners and furrows across the ends. This is the continuation of the plan shown in Figure 10

unplowed in the corners of the field as there is in plowing the headland around a field, the body of which has been plowed by running with the plows idle across the ends. (See fig. 7.)

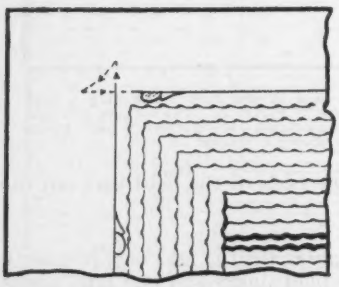

FIG. 12.—Method IV, corner turns: The square turns shown in Figure 11 are made by backing around the corners on a triangle

Except for these last few rounds, the net result of plowing a field by this method is the same as is ordinarily attained by plowing a backfurrow land with horses. The greatest objection is probably the time and travel necessary to make the turn to the left at each corner. This travel at each corner will amount to just about a complete circle. For a tractor with a 20-foot turning radius, this means something over 100 feet of travel. Many large tractors pulling several plows have a considerably greater turning radius than this. Thus the loss of time in many cases would be too great for this method to be advisable.

If the plows are hitched to the tractor in such a way that the machine can be backed easily, the turns can be made by backing it around through a quarter of a circle, as indicated in Figure 12, with a comparatively small loss in time. Such an outfit can make these turns until the field is practically finished.

METHOD V

In this method the operator starts plowing at the outside of the field, as shown in Figure 13, throwing the furrow toward the fence and turning to the left at the corners without lifting the plow. A rectangular field like that shown is plowed in a single land with one deadfurrow. The corners will have to be rounded to a certain extent on the first trip around the field, and kept this way throughout the plowing so as to permit the tractor to make the turns without encroaching too far on the plowed ground or getting the furrows irregular and crooked near the corners. The plows will be pulled away from the last open furrow to a certain extent in making the turns and the diagonal strips running from the ends of the deadfurrow to the corners of the field will usually have to be replowed. (See figs. 14 and 15.)

It is not necessary to measure any distances when this scheme of plowing is followed, and this will save some time over any of the schemes heretofore described. On the first round the plows can often be set over to the right and the ground turned nearer the fence

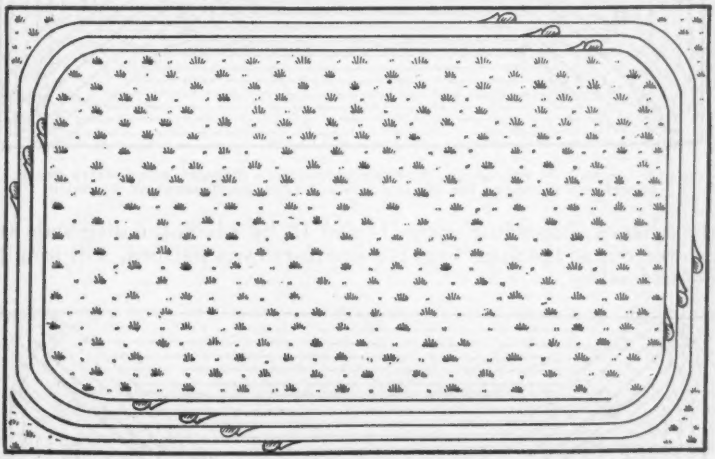

FIG. 13.—Method V, first stage: Plowing around a rectangular field by turning the furrows toward the fence, rounding the corners enough to permit turning without lifting the plows

than is possible in the two preceding backfurrow methods. The plows are left in the ground from the time the field is entered until the deadfurrow at the center is reached. This feature makes the method desirable if the plow is not equipped with a power lift. A field with slightly irregular or crooked boundaries can be plowed by following this scheme, practically as good a job being possible with no more effort than in a rectangular field. This method is very popular with many tractor operators and has been adopted almost exclusively where disk plows are used.

The body of the field can be plowed to a deadfurrow in the center and the diagonal strips running in from the corners where the turn is made may be replowed one at a time or left to be plowed with horses. When this method is used it is necessary to pull out on to the plowed ground to turn, as the deadfurrow is approached and the unplowed land becomes narrow, also it is necessary to travel over

the plowed ground in making the turns at the center of the field when plowing the diagonals. Unless horses are to be used for this, one of

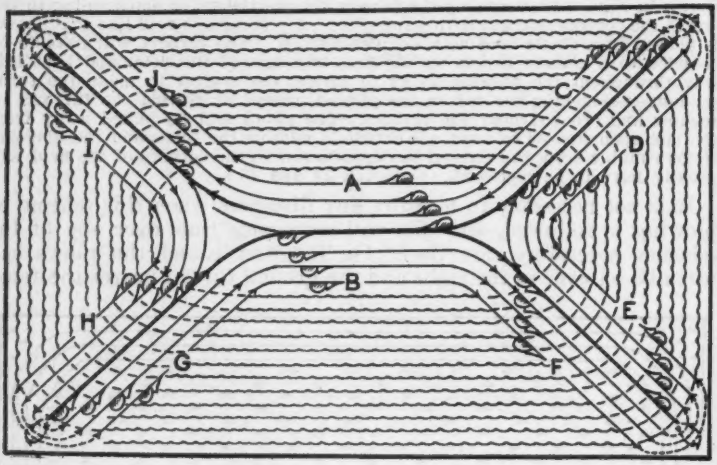

FIG. 14.—Method V, final stage: Plan for plowing the diagonal strips which are left imperfectly plowed at the turning points, leaving deadfurrows at the finish

the schemes shown in Figures 14 and 15, by which the diagonals are plowed out at the same time the deadfurrow is finished, will usually be preferable.

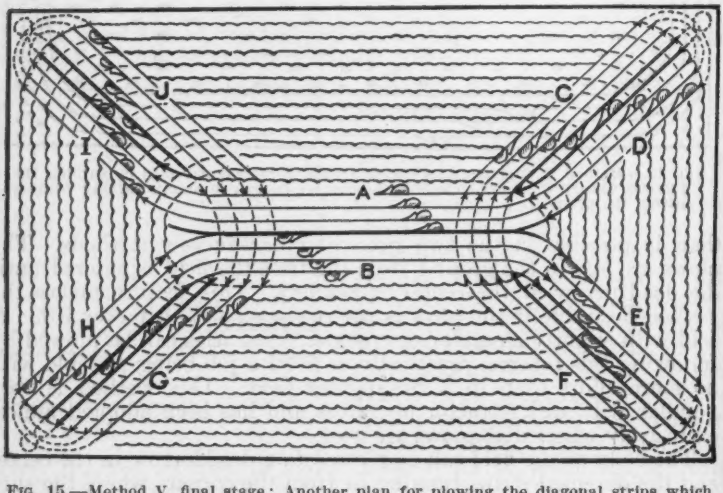

FIG. 15.—Method V, final stage: Another plan for plowing the diagonal strips which are left at the turning points in Figure 13, leaving a backfurrow in these and a deadfurrow in the center

By the scheme shown in Figure 14, a deadfurrow is left along each diagonal, and by the scheme shown in Figure 15, a backfurrow is made along the

middle of the diagonals, with open furrows on each side. If the first-mentioned scheme is to be employed, when the distance from *A* to *B* (see Figure 14) becomes the same as that from *C* to *D*, *E* to *F*, etc., the width to be replowed along the diagonals, turn to the right from the furrow next to *A* and follow along the line indicated through *J*, *I*, *H*, *G*, *B*, etc., and continuing in this way until the diagonals and center are finished.

The tractor will have to do very little traveling over the plowed ground and if care is taken to get all the distances exact, the whole field, with the exception of the parts left for making the short turns at the corners, can be finished at the same time. The only times the plows are lifted are on the few short turns at the corners in plowing the diagonals.

If it is desired to have backfurrows along the diagonals instead of dead-furrows, the method of procedure will be as shown in Figure 15. It is similar to that shown in Figure 14 except that the backfurrows are thrown up on the first trips along the diagonals. The turn is to the right at the corner of the field each time, the plows are taken out of the ground in going between the two diagonals at the same end of the field, and the outfit will have to travel over the plowed ground a little more at these points.

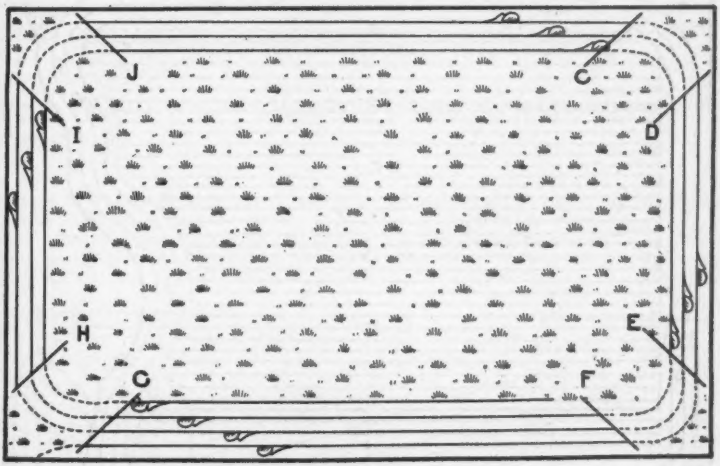

FIG. 16.—Method VI. Plowing around a rectangular field as in Method V. The plows are lifted at the turns, as shown by the dotted lines

METHOD VI

This is like the preceding method except that the plows are lifted each time at the corners in plowing the body of the field, and the diagonals are left entirely unplowed until the finish of the field. Care must be taken to get the width of all the diagonals—that is, from *C* to *D*, *E* to *F*, etc., in Figure 16—the same if either of the methods shown in Figures 14 and 15 is to be used in finishing the field. The width should be ample for turning the outfit and getting it in line with the furrow, before the point where the plows are to be put into the ground again is reached. It will be better to make an extra round in plowing out the diagonals than to be cramped for space at every turn in plowing the body of the field.

IRREGULAR FIELDS

Irregular fields have such a variety of shapes and present such a variety of conditions that it is impossible to give any definite directions applicable to all. If the field is comparatively level, and the irregularities are confined to the boundaries on one or two sides, some one of the methods described for rectangular fields can usually be adopted.

Figure 17 illustrates a field with the irregularities confined to a stream which forms the boundary at one end. Usually such a field can be plowed satisfactorily by one of the methods where the plows are taken out of the ground in going across the end, as is shown in the figure. The procedure will be the same as in a rectangular field except in laying out the headland across the end adjacent to the stream. There the line for lifting the plows and letting them into the ground must be made parallel to the stream if the field is to be

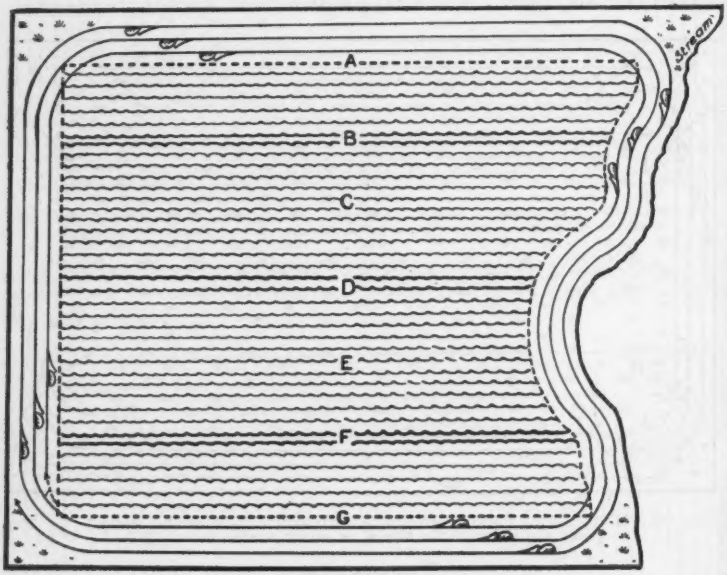

FIG. 17.—Plan for plowing a field having one irregular side

finished without undue loss of time in plowing the headland along the stream. If the headland is plowed by turning to the left so that the first round will take in the irregularities along the stream, it will probably be less difficult to finish it satisfactorily than if it is plowed by turning to the right, as shown in the figure.

If the irregularity is simply due to a road, railroad, or a farm boundary which is a straight line but does not run at right angles to the other boundary lines that join it, the problem of laying out and plowing the headland will be little, if any, more difficult than in a rectangular field.

Method V or VI (see p. 13) can often be used satisfactorily for plowing such fields. If the irregularity is along one or both ends, but the sides of the field still straight and parallel, the irregularity will entirely disappear before the deadfurrow is reached.

A good method of plowing a triangular field is shown in Figures 18 and 19. This is really a variation of Method VI, described on page 15. The body of the field is plowed by starting next to the fence, going round and round the field, turning always to the left, and lifting the plows at the corners. The distances

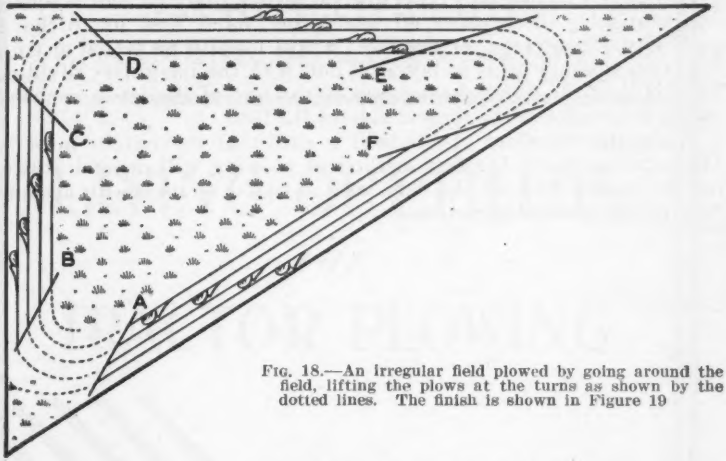

FIG. 18.—An irregular field plowed by going around the field, lifting the plows at the turns as shown by the dotted lines. The finish is shown in Figure 19

from *A* to *B*, *C* to *D*, and *E* to *F*, in Figure 18, should all be made the same, and should be great enough to permit easy turning at the most acute angle of the field. That is, in a field such as that shown, the distance from *E* to *F*, which must be left for the sharp turn at this corner, should determine the distances from *A* to *B* and *C* to *D*. When the body of the field is finished, there will be

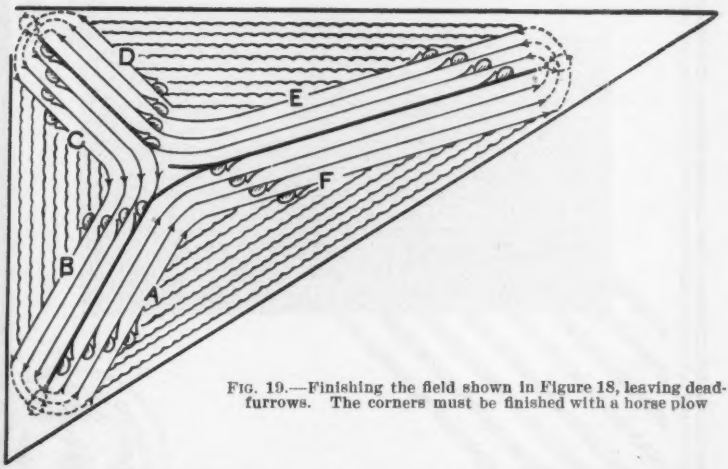

FIG. 19.—Finishing the field shown in Figure 18, leaving dead-furrows. The corners must be finished with a horse plow

three strips, all the same width, one extending into the center of the field from each corner, left to be plowed in the manner indicated in Figure 19.

A four-sided field which has one of the long sides not parallel to the other can be laid out into two parts, one a rectangular plat and

the other a triangular plat as illustrated here. The rectangular part can be plowed in any desired manner and the triangular part as here described.

If a field which would otherwise be rectangular has had a square or rectangular piece taken off one corner for a feed lot, orchard, part of the farmstead, or the like, it will usually be better to treat it as two separate fields in laying it out, with the imaginary dividing line between the two, an extension of the line of the lot or orchard, which is parallel to the longest side of the field.

When the character of the field is such that its contour must be taken into account, the best method of plowing will depend always on the peculiarities of the field, and it would be useless to attempt to give any general directions.

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LAYING OUT FIELDS *for* TRACTOR PLOWING

TRACTOR PLOWING usually requires methods of laying out fields different from those followed in plowing with horses and an ordinary plow.

Farmers using a tractor for plowing are often at a loss to find the most satisfactory method of laying out their fields.

A method admirably suited to one size of tractor under certain field conditions may not be satisfactory for some other size or under different conditions.

This bulletin describes the more common methods recommended by farmers who use tractors for plowing. Among these will be found methods suited to laying out fields of different shapes.

Washington, D. C.

Issued May 1919
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LAYING OUT FIELDS FOR TRACTOR PLOWING

By C. D. KINSMAN, *formerly agricultural engineer, Bureau of Public Roads,* and L. A. REYNOLDSON, *formerly associate economic analyst, Bureau of Agricultural Economics* [1]

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FACTORS TO BE CONSIDERED IN MAKING PLANS FOR TRACTOR PLOWING

FARMERS who plow with tractors want to do a high-class job of plowing over the entire field and to reduce to a minimum the time spent in turning and in traveling with plow bottoms out of the ground. To accomplish this they must choose the method which is best suited to their conditions. Many circumstances must be considered in deciding just what method is best for a particular field with a particular outfit. There is no one method which can be considered best for every size and shape of field.

Methods of laying out fields for tractor plowing fall into two classes: (1) Those in which the bottoms are lifted in crossing the ends; (2) those in which they are not lifted. The advantages of methods of the first class are that short turns are eliminated, except in some cases at the beginning and ending of the lands, and that it is generally possible to do a little higher quality of plowing at the corners or turns. The advantages of methods of the second class are that little or no time is lost in traveling with the bottoms out of the ground and that ordinarily the number of deadfurrows and backfurrows will be considerably less.

The longer the time spent in turning or running with the bottoms lifted, the smaller the acreage that can be plowed in a day; on the other hand, the making of short turns is awkward with some tractors, particularly the larger ones, and the operator often has difficulty in getting the outfit in the correct position for starting the furrows after such turns have been made. Though it may pay to make some

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additional effort to avoid short turns when using a large tractor, it should be borne in mind that the loss in time and fuel due to making long idle runs across the ends of the field is just as serious with the large as it is with the smaller, more easily handled tractor. The time lost in making loop turns in starting and finishing a large number of lands is less with a tractor having brakes to assist in making short turns. This should be taken into consideration in deciding on the most desirable size and number of lands. From the standpoint of time lost in idle running, the size of the tractor should be considered only with reference to the relative difficulty in making short turns.

In deciding on the method to use, the ease of handling the tractor and plow is not always the most important thing to consider. In areas of heavy rainfall it may be best to make narrow lands with frequent deadfurrows and backfurrows as an aid to drainage; in dry areas the reverse may be true. In other cases the contour or shape of the field may be such as to determine almost entirely the method that must be followed.

If the field is rectangular and level enough so that the contour does not have to be considered, the choice between a method of the first class and one of the second class will usually depend on how short a turn can be made with the tractor and plow and how objectionable the additional backfurrows and deadfurrows are.

METHODS IN WHICH BOTTOMS ARE LIFTED AT THE ENDS

If it is decided that a method of the first class, in which the bottoms will be out of the ground in going across the ends of the field, is to be used, it must then be decided into how many lands the field should be divided for best results, how wide to leave the head lands on which to turn, and where to set the guide stakes or markers.

WIDTH AND NUMBER OF LANDS

The wider the lands are made the fewer will be the deadfurrows and backfurrows, but the greater will be the time consumed in idle running across the ends. Some idea of the distance traveled with the bottoms out of the ground can be obtained by considering a specific case.

Suppose a field 40 rods wide is to be plowed in this manner, one land at a time, and that it is laid off into five lands of 132 feet each. If the tractor is pulling a three-bottom 14-inch plow, it will take about 38 trips across the field to plow out each land. If the extra distances that the tractor must cover in swinging out of the furrow and back into it again, and in making the short or figure-eight turns in starting a backfurrow land or finishing a deadfurrow are ignored, the average length of travel across the ends—that is, the average distance in a straight line from where the bottoms are lifted out of the ground to where they enter it again—is half the width of the land, or 66 feet. This makes 2,508 feet, or almost a half mile, for each land, and almost 2½ miles of idle travel in plowing the entire field.

If the field were laid out in 11 lands, each 60 feet wide, the unproductive travel at the ends would be reduced to approximately 1 mile,

but this reduction would be largely offset by the greater number of figure-eight turns necessary in starting the extra lands and also the probability of the plow running at less than its full width of cut for a considerable distance in finishing the extra number of lands; if the field were laid out in only three lands the travel across the ends would be increased to about 4 miles, but there would be only two deadfurrows to finish out with the possibility of the plow not cutting its full width.

The longer time necessary to make the difficult turns at each backfurrow or deadfurrow, which must be added to the time to travel these straight-line distances, will reduce the advantage of the narrow lands in this respect to a certain degree; but ordinarily a tractor that pulls a three-bottom plow and has a comparatively short turning radius and makes short turns fairly quickly, will plow a strip 40 rods wide laid out in five lands in about an hour less than if it were laid out in three lands.

The length of the field is also of importance in deciding the width of the land, since the time lost in turning on a short field for a given width of land is much greater in proportion to the total time required to plow it than on a long field. For this reason a wider land is usually selected when the field is long than for short fields.

The dimensions of the field will determine whether the saving in time in making narrow lands is sufficient to offset the disadvantages of the extra deadfurrows and backfurrows and any difficulties of making short turns. The most popular width under average conditions seems to be about 100 feet for a two- or three-bottom plow. However, if the field has no irregularities, its entire width should be measured and divided into lands of approximately equal width.

HEADLANDS

The width of the headland will depend largely on the total length of the tractor and plow and the turning radius of the tractor. Some farmers with very easily handled outfits do not leave more than 10 to 15 feet; however, any extra ground in the headland can be plowed just as quickly as if it were plowed with the body of the field, and plenty of room should always be left to allow easy turning and to get the outfit headed in properly at the beginning of the furrows. The wider the headland, the less the tendency to go over the same ground repeatedly in turning at the ends and to pack it tight when plowing out the lands.

Headlands 15 to 25 feet wide may be suitable when one of the smaller outfits is to be used. Most tractors built recently can be turned in less space than is required by some of the older models. With a large tractor pulling two or more units of plows it may be desirable to make the headlands 75 to 100 feet wide. With most outfits a headland one and a half times the total length of the tractor and plow will give plenty of room for turning. It is a good idea, particularly with the larger outfits, to make the border or headlands a multiple of the width cut by the plow. That is, a headland 17½, 21, 24½, or 28 feet wide would plow out even in 5, 6, 7, or 8 rounds with a three-bottom 14-inch plow taking a full cut every round.

If the field is fenced on all sides a border the same width as the headlands may be left on each side, and it will be possible to finish the field neatly by plowing around the entire field, throwing the furrows either in or out as is required to keep the field level.

If one end of the field is unfenced and the outfit can be pulled out into a road or lane or an adjoining field for turning, it may be preferable to plow up to the fences on the two sides as the body of the field is being plowed and leave only the one headland across the end of the field which is fenced. Such a headland may be plowed later with either a deadfurrow or backfurrow through the center.

Many farmers mark the edge of the headland by plowing a shallow "scratch furrow" across the end of the field before starting on the lands. This makes it easier to keep the ends of the furrows even and the headlands uniform in width. It seems to make little difference whether the scratch furrow is thrown toward or away from the edge of the field, but throwing the furrow away from the edge of the field seems to be the more common practice. This furrow across the end of the field sometimes helps the bottoms to enter the ground more quickly at the beginning of each round.

SETTING STAKES AND MARKERS

To finish up a field in the best manner without having to plow irregular or wedge-shaped strips it is essential that the lands be started straight and parallel and that the headlands be kept uniform in width. If a field is once laid out accurately and marked permanently it will not be necessary to measure off lands at each plowing. In fields that are fenced, the locations of deadfurrows and backfurrows may be readily marked by setting stakes along the fence. After this has been done, old deadfurrows can readily be found when plowing the new backfurrows even if the field is covered with tall weeds.

Most farmers "step off" the distances between lands. This method is sufficiently accurate for a lay-out in many cases, but when a permanent lay-out is to be made or a large number of narrow lands are to be laid out it may be advisable to use a tape or some other accurate method.

METHOD 1

Method 1 is probably the most popular and the most generally used of the methods in which the bottoms are lifted at the ends of the field. Two plans used alternately are advisable to maintain a level field. The method as applied to a 20-acre field 40 rods wide and 80 rods long will be outlined. With headlands 33 feet wide, the body of the field will be 36 rods wide. For such a field the two following plans may be used alternately.

PLAN A

(1) Lay out a backfurrow through the center of the field at *C*, figure 1, and plow a strip 12 rods wide about the backfurrow, lifting the bottoms 2 rods from each end of the field.

(2) Plow along one side of the land already plowed, at *B*, figure 1, turn to the left and, on the return trip across the field, plow with the first furrow 2 rods from the edge of the field to allow for the

border. Continue plowing, turning to the left until the deadfurrow is finished at *A*, which will be 6 rods from the inside edge of the border.

(3) Plow the last third of the field between the border and the furrow at *D*, figure 1, turning left at the ends and finishing the body of the field with the deadfurrow at *E*.

(4) Plow the border, traveling around the field to the right and turning the furrows toward the center of the field. This will produce two more backfurrows at the inner edge of the border on each side of the field. The field is thus finished with a single open furrow around the edge of the field.

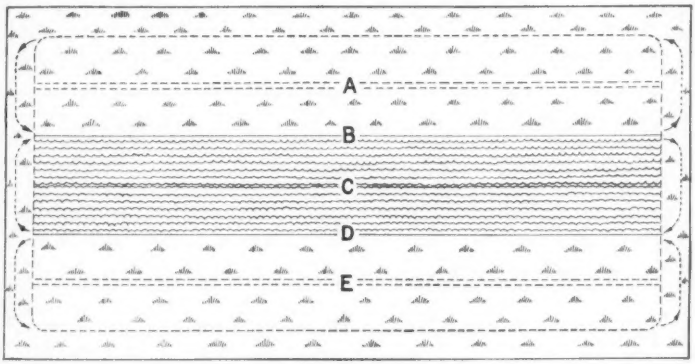

FIGURE 1.—Method 1, plan A, at the end of the first step. The locations of the two deadfurrows are shown by the double dotted lines, *A*, *E*. The direction of travel across the ends is indicated by dotted lines and arrows.

PLAN B (ALTERNATE WITH PLAN A)

This plan will be suitable for use at the next plowing after plan A, just described. Plan B applies to the field plowed according to plan A at the last plowing.

(1) There will be old deadfurrows at *A* and *E* (fig. 2). Plow a backfurrow at *A* and, turning to the right about this backfurrow, continue plowing until the one side of the land is 2 rods from the side of the field. The border is to be the same width as in plan A. The land should then be 12 rods wide.

(2) Lay out a backfurrow in the old deadfurrow at *E* (fig. 2) and plow, turning to the right until the one side of the land is 2 rods from the side of the field.

(3) One-third of the body of the field, a strip 12 rods wide, remains to be plowed between the two lands plowed in the first and second steps. Plow this out, turning to the left and finishing with a deadfurrow at *C*, through the center of the field.

(4) Plow the border. Since the furrows were thrown toward the center of the field in plowing the border at the last plowing, they should be thrown in the opposite direction at this plowing. It will then be necessary to travel around the field turning to the left, beginning at the outside of the field. This will finish the field with a dead furrow on each side at the inside edge of the border.

ALTERNATE MANNER OF FINISHING BORDERS UNDER METHOD 1

Backfurrows and deadfurrows between the border and the body of the field can be avoided as follows: When using plan A, plow the border as the first step, before plowing the body of the field, and throw the furrows away from the edge of the field, as explained in finishing plan B above. Then when plan B is used, the furrows can be thrown in again, and in this case the border would logically be plowed last.

If this method is used and the border plowed first, as in plan A, it is only necessary in laying out a field 40 rods wide to determine the location of the backfurrow through the center of the field parallel to the sides of the field and to determine when the middle third of the field has been plowed. Measuring the border width and staking out are unnecessary because the first step will be to plow around the field.

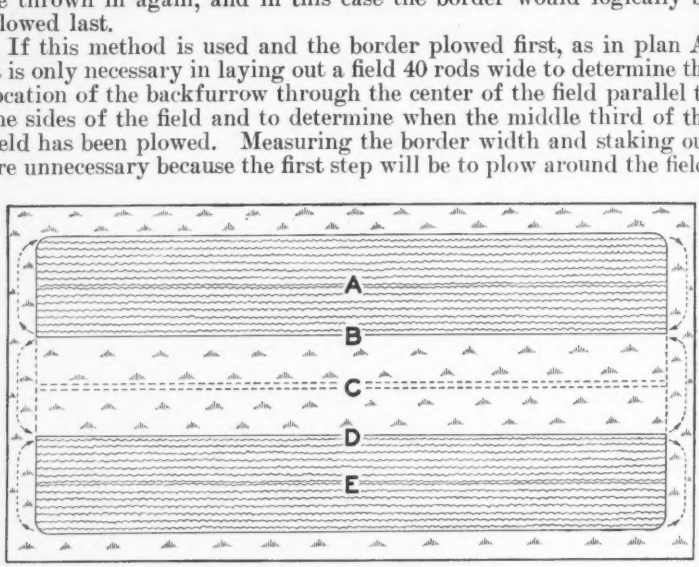

FIGURE 2.—Method 1, plan B, at the end of the second step. Note the two backfurrows at *A* and *E* are where the two deadfurrows were in plan A and the deadfurrow at *C* is where the backfurrow was at the previous plowing.

beginning at the edge and throwing the furrows out until the proper number of rounds are made and the border is the desired width. It is a little more difficult to make short turns on plowed ground and if it should be found, after the land is started in the center of the field, that a wider headland is needed another round or two can be plowed around the border. This will not affect the application of the plan.

This method may be used with a greater number of lands in order to make the lands narrower than outlined in this particular example or in order to adapt the method to wider fields. It should be noted that, in following method 1, half of the land between any two deadfurrows in the body of the field is first plowed, turning to the right about the backfurrow, and the other half is then plowed, turning to the left until the deadfurrow is finished. Disregarding any extra travel in making figure-eight turns at the beginning of a backfurrow or finishing a deadfurrow, and with any given number of lands, the least possible amount of time is spent in unproductive travel across the ends. With this method, where a complete border is to be plowed, there should always be a plan similar to plan A with an odd

number of backfurrows and an alternate plan similar to plan B with an even number of backfurrows.

VARIATIONS OF METHOD 1

Where there is a roadway at one end of the field suitable for turning or where there is no fence and the turns can be made in the adjacent field it may be desirable to omit the border. If the turns must be made within the field at one end this headland can be plowed as a narrow land about a backfurrow at one plowing and the opposite way at the next plowing, finishing with a deadfurrow. This may be plowed before or after plowing the main part of the field, as desired, regardless of whether plan A or plan B is followed for the rest of the field.

Similarly a narrow land may be plowed at each end of the field instead of a complete border. In this case the field need not be laid out with the backfurrows placed symmetrically, as in plans A and B, but may be laid out and plowed as in method 2, which follows.

METHOD 2

Method 2 might be considered another variation of method 1. It is similar to the previous method except that there are always the same number of backfurrows as deadfurrows; the two alternate plans under method 2 are alike except that the positions of the backfurrows and deadfurrows are reversed.

PLAN C

A 20-acre field 40 by 80 rods will again be used as an example, and the body of the field will be plowed in lands so that the maximum distance of unproductive travel across the end will be 10 rods.

(1) Lay out a backfurrow at *A*, figure 3, one-eight of the width of the field or 5 rods from one edge of the field, and plow, turning to the right around this backfurrow, until the side of the field is reached. This land will then be 10 rods wide, and one-fourth of the field will be plowed.

(2) Lay out another backfurrow, at *C*, three-eights of the width of the field or 15 rods from the opposite side of the field and again plow a land 10 rods wide or one-fourth of the field.

(3) Plow out the strip between these two lands, finishing with a deadfurrow at *B*.

(4) Plow the remaining one-fourth of the field, turning to the left at the ends and finishing with the deadfurrow at *D*.

(5) Plow the headlands. These may be plowed as the first step, if desired, and will serve as guide lines at the ends of the lands instead of scratch furrows.

PLAN D (ALTERNATE WITH PLAN C)

Plan D is to alternate with plan C and is the same as plan C except that it is reversed. Backfurrows would be laid out at *D* and *B* (fig. 3), and those two lands would be plowed before lands *A* and *C*. Alternating plan D with plan C maintains levelness in the field.

METHODS IN WHICH BOTTOMS ARE LEFT IN THE GROUND IN GOING ACROSS THE ENDS

The objections to the methods already described are that they necessitate a considerable amount of travel with the bottoms idle and that there are many deadfurrows and backfurrows if an attempt is made to reduce the amount of this idle travel. The use of any of those methods usually results in a somewhat better job of plowing than use of a method involving an attempt to keep the bottoms in the ground all the time the tractor is travelling; but many farmers think that the possible reduction in quality of the work is not sufficient to offset the saving of time effected by eliminating idle travel.

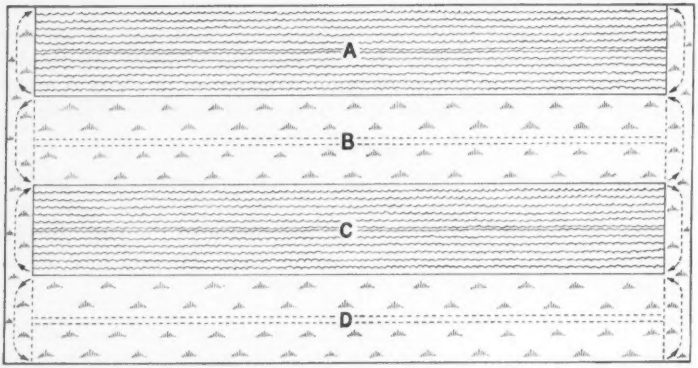

FIGURE 3.—Method 2, plan C, at the end of the second step. The order of plowing might also be *C*, *D*, *A*, and *B*. Each headland is plowed separately either before or after plowing the body of the field.

METHOD 3

By method 3 a rectangular field is plowed around a single backfurrow at the middle of the field. The bottoms are lifted only in making the comparatively few short turns on the first few trips across the ends of the field. After the plowed land becomes wide enough for the outfit to turn around the ends, the bottoms are never lifted from the ground until the field is finished.

The position and length of the backfurrow (from *A* to *B*, fig. 4) at the center of the field is determined in much the same manner as is often done in laying out a field for backfurrow plowing with horses. Make the distance from *A* to *G* enough shorter than that from *A* to *C* so that when the land is rounded off at the ends and plowing entirely around the land is begun, as indicated in figure 5, the furrows across the end will be the same distance from the edge of the field as are the furrows down the sides. The point *B* should be the same distance from the end of the field as *A*.

On the first few trips across the field, pull the outfit over to the right every time as the end is approached, so as to get the corners rounded off as soon as possible sufficiently to permit the outfit to make the turn without lifting the bottoms. Lift the bottoms and make a complete circle to the left in turning. The number of times the bottoms will have to be lifted at the ends and the outfit turned to

the left in order to get the ends in shape to go around with the bottoms in the ground will depend mostly on the turning radius of the

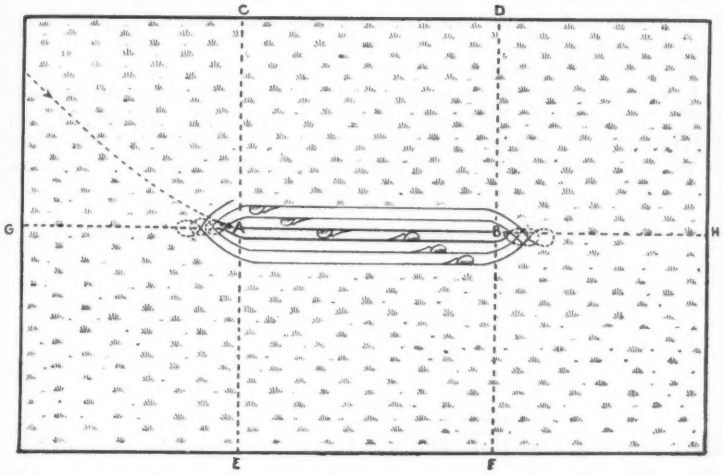

FIGURE 4.—Method 3, first stage. To begin plowing in the center of the field, a backfurrow *AB* is laid out in the center of the field, the distance from *A* to *C* equal to that from *A* to *E*. The continuation of this plan is shown in figure 5.

outfit and the width of the strip plowed at each trip. For some large outfits the land may have to be 75 feet or even more in width before

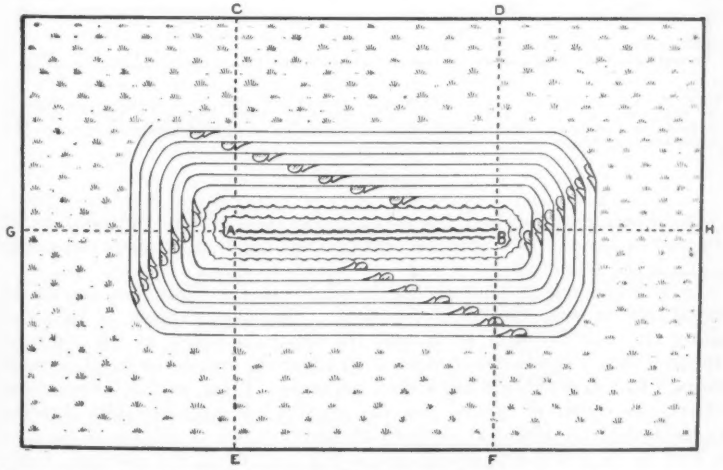

FIGURE 5.—Method 3, second stage. Plowing around the central backfurrow started in figure 4 until the field is finished.

this can be done, while a small outfit with a short turning radius may be able to turn about a strip half as wide.

Some care will be necessary in steering the tractor at the turns after the land becomes wide enough to permit leaving the bottoms

in the ground continuously, as in figure 5, if the turns are to be kept abrupt. The shorter the turns are kept the smaller will be the triangular pieces left in the corners of the field at the finish. However, if the tractor runs with one or two of the wheels in the furrow, it may be preferable to let the corners round off as they will and finish with horses later.

If the field is square, or nearly so, it can be plowed in two or more lands, each one laid out according to this method. In such a case extra pieces, each approximately twice as large as the unplowed pieces at the corners, will be left at the ends of the field between the lands.

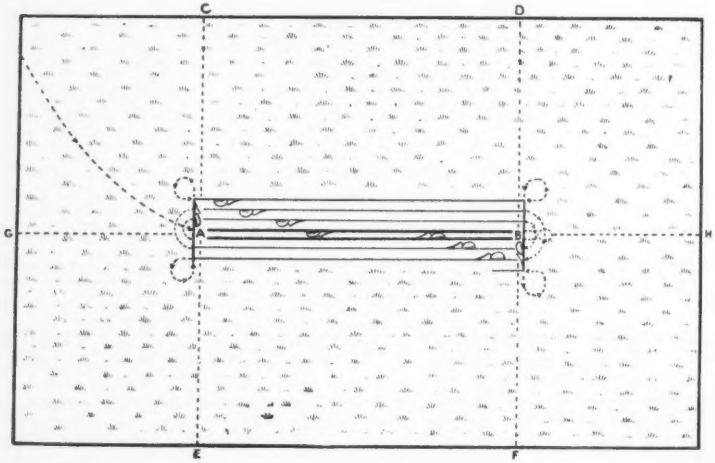

FIGURE 6.—Method 4, first stage. Plowing a field in one land by starting a backfurrow in the center of the field, the same as in figure 4. The corners are kept square by making short turns to the left and swinging around so as to plow across the ends. The continuation of this plan is shown in figure 7.

METHOD 4

In plowing by method 4 a rectangular field is laid out, just as in the preceding method, and the entire field plowed in one land about a single backfurrow.

In a field such as that shown in figure 6, the distances should be measured as was shown in figure 4. The backfurrow is laid out along the line from *A* to *B* and the bottoms lifted at the ends on the first few rounds, as indicated in figure 6, until the land is wide enough to warrant plowing across the ends. Then, as the bottoms are lifted, the outfit is turned sharply to the left and brought around, as indicated by the dotted lines at the corners in figure 6, so that it will be in line for plowing across the end when the bottoms reach the place where the furrows should begin. The corners are kept square by turning in this way (fig. 7) until the furrows get so near the fence that not enough room is left to make such a turn. Then the corners must be rounded and the tractor turned to the right.

Since this scheme keeps the corners square, except for the last few rounds, approximately the same amount of ground will be left un-

plowed in the corners of the field as is left in plowing the headland around a field, the body of which has been plowed by running with the bottoms idle across the ends.

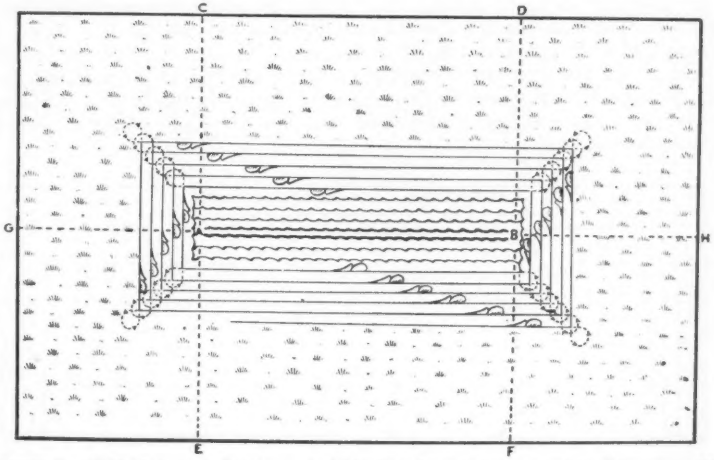

FIGURE 7.—Method 4, second stage. A field plowed around a central backfurrow, with square corners and furrows across the ends. This is the continuation of the plan shown in figure 6.

Except for these last few rounds, the net result of plowing a field by this method is the same as is ordinarily attained by plowing a backfurrow land with horses. The greatest objection is probably the time and travel necessary to make the turn to the left at each corner. This travel at each corner will amount to just about a complete circle. For a tractor with a 20-foot turning radius, this means something over 100 feet of travel. Many large tractors pulling several units of plows require a considerably greater turning radius than this. Thus the loss of time in many cases would be too great for this method to be advisable.

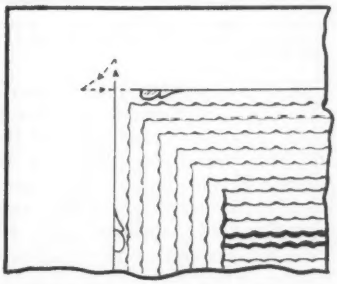

FIGURE 8.—Method 4, corner turns. The square turns shown in figure 7 are made by backing around the corners on a triangle.

If the plows are hitched to the tractor in such a way that the outfit can be backed easily, the turns can be made by backing around through a quarter of a circle, as indicated in figure 8, with a comparatively small loss in time. Such an outfit can make these turns until the field is practically finished.

METHOD 5

In method 5 the operator starts plowing at the outside of the field, as shown in figure 9, throwing the furrows toward the fence and turning to the left at the corners without lifting the bottoms.

A rectangular field like that shown is plowed in a single land with one deadfurrow. The corners will have to be rounded to a certain extent on the first trip around the field, and kept this way throughout the plowing so as to permit the tractor to make the turns without encroaching too far on the plowed ground or getting the furrows irregular and crooked near the corners. The plow will be pulled away from the last open furrow to a certain extent in making the turns, and the diagonal strips running from the ends of the deadfurrow to the corners of the field will usually have to be replowed (figs. 10 and 11).

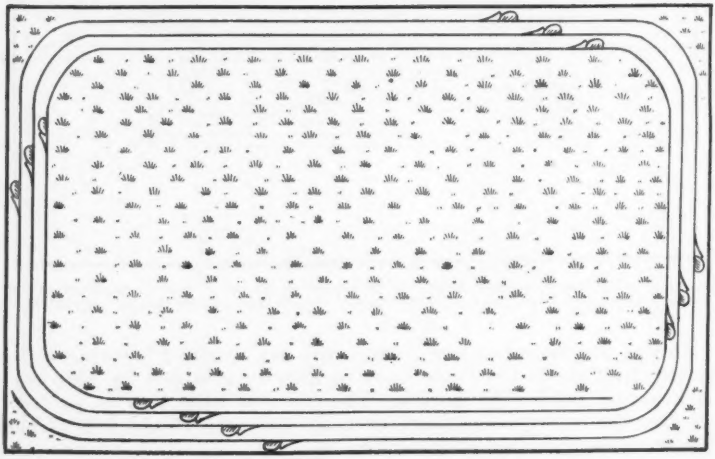

FIGURE 9.—Method 5, first stage. Plowing around a rectangular field by turning the furrows toward the fence, rounding the corners enough to permit turning without lifting the plows.

It is not necessary to measure any distances when this method of plowing is followed, and omitting the measuring will make this method quicker than any of the methods heretofore described. On the first round the plow can often be set over to the right and the ground turned nearer the fence than is possible in the two preceding backfurrow methods. The bottoms are left in the ground from the time the field is entered until the deadfurrow at the center is reached. This feature makes the method desirable if the plow is not equipped with a power lift. A field with slightly irregular or crooked boundaries can be plowed by following this method, practically as good a job being possible with no more effort than in a rectangular field. This method is very popular with many tractor operators and has been adopted almost exclusively where disk plows are used.

The body of the field can be plowed to a deadfurrow in the center, and the diagonal strips running in from the corners where the turn is made may be replowed one at a time or left to be plowed with horses. When this method is used it is necessary to pull out on to the plowed ground to turn, as the deadfurrow is approached and the unplowed land becomes narrow, also it is necessary to travel over the plowed ground in making the turns at the center of the field when plowing

the diagonals. Unless horses are to be used for this, one of the methods shown in figures 10 and 11, by which the diagonals are

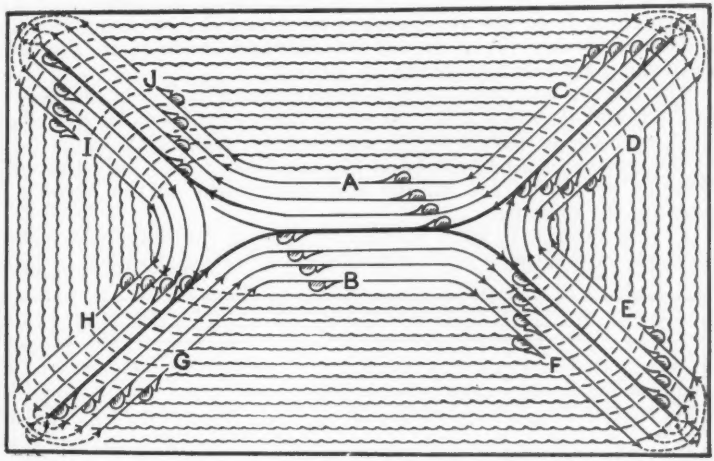

FIGURE 10.—Method 5, final stage. Plan for plowing the diagonal strips which are left imperfectly plowed at the turning points, leaving deadfurrows at the finish.

plowed out at the same time deadfurrow is finished, will usually be preferable.

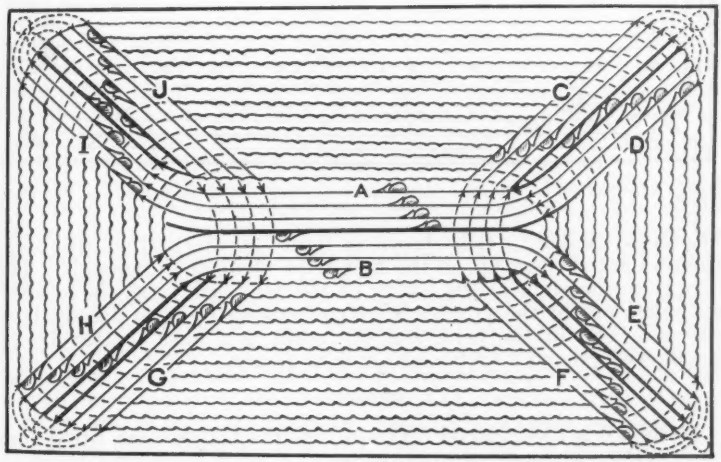

FIGURE 11.—Method 5, final stage. Another plan for plowing the diagonal strips which are left at the turning points in figure 9, leaving backfurrows at these points and a deadfurrow in the center.

By the method shown in figure 10 a deadfurrow is left along each diagonal, and by the method shown in figure 11 a backfurrow is made along the middle of each diagonal and open furrows on each

side. If the first-mentioned method is to be employed, when the distance from *A* to *B* (fig. 10) becomes the same as that from *C* to *D*, *E* to *F*, etc., the width to be replowed along the diagonals, turn to the right from the furrow next to *A* and follow along the line indicated through *J*, *I*, *H*, *G*, *B*, etc., and continue in this way until the diagonals and center are finished.

The tractor will have to do very little traveling over the plowed ground, and if care is taken to get all the distances exact the whole field, with the exception of the parts left for making the short turns at the corners, can be finished at the same time. The only times the bottoms are lifted are on the few short turns at the corners in plowing the diagonals.

If it is desired to have backfurrows along the diagonals instead of deadfurrows, the method of procedure will be that shown in figure

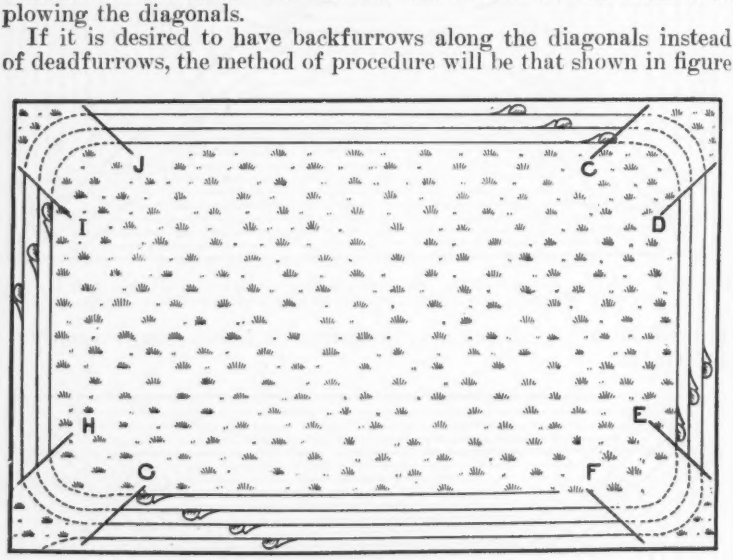

FIGURE 12.—Method 6. Plowing around a rectangular field as in method 5. The plows are lifted at the turns, as shown by the dotted lines.

11. It is similar to that shown in figure 10 except that the backfurrows are thrown up on the first trips along the diagonals. The turn is to the right at the corner of the field each time, the bottoms are taken out of the ground in going between the two diagonals at the same end of the field, and the outfit will have to travel over the plowed ground a little more at these points.

METHOD 6

Method 6 is like method 5 except that the bottoms are lifted each time at the corners in plowing the body of the field and the diagonals are left entirely unplowed until the finish of the field. Care must be taken to get the width of all the diagonals—that is, from *C* to *D*, *E* to *F*, etc., in figure 12—the same if either of the methods shown in figures 10 and 11 is to be used in finishing the field. The width should be ample for turning the outfit and getting it in line with the furrow before the point is reached where the bottoms are to

be put into the ground again. It will be better to make an extra round in plowing out the diagonals than to be cramped for space at every turn in plowing the body of the field.

IRREGULAR FIELDS

Irregular fields have such a variety of shapes and present such a variety of conditions that it is impossible to give any definite directions applicable for all. If the field is comparatively level, and the irregularities are confined to the boundaries on one or two sides, usually some one of the methods described for rectangular fields can be adopted.

Methods 1 and 2, as shown in figures 1, 2, and 3, may be readily adapted to fields with two long parallel sides and one or both ends irregular. Plans A and B or C and D may be used in fields of this shape. It is obvious that the lands should be plowed in the direction of the parallel sides of the field. Fields having only one long straight side may also be plowed by using method 1 or method 2 and making the obvious adaptations. In fields where the ends are far from a right angle to the direction of plowing it is suggested that the lands be made rather narrow in order to reduce the unproductive travel across long angular ends.

Figure 13 illustrates a field with the irregularities confined to a stream which forms the boundary at one end. Usually such a field can be plowed satisfactorily by using one of the methods in which the bottoms are lifted in traveling across the end, as is shown in figure 13. The procedure will be the same as in a rectangular field except in laying out the headland across the end adjacent to the stream. There the line for lifting the bottoms and letting them into the ground must be made parallel to the stream if the field is to be finished without undue loss of time in plowing the headland along the stream. If the headland is plowed by turning to the left so that the first round will take in the irregularities along the stream, it will probably be less difficult to finish it satisfactorily than if it is plowed by turning to the right, as shown in the figure.

If the irregularity is simply due to a road, railroad, or a farm boundary which is a straight line but does not run at right angles to the other boundary lines that join it, the problem of laying out and plowing the headland will be little, if any more difficult than in a rectangular field.

A good method of plowing a triangular field is shown in figures 14 and 15. This is really a variation of method 6, described on page 14. The body of the field is plowed by starting next to the fence, going round and round the field, turning always to the left, and lifting the plows at the corners. The distances from *A* to *B*, *C* to *D*, and *E* to *F*, in figure 14, should all be made the same and should be great enough to permit easy turning at the most acute angle of the field. That is, in a field such as that shown, the distance from *E* to *F*, which must be left for the sharp turn at this corner, should determine the distances from *A* to *B* and *C* to *D*. When the body of the field is finished there will be three strips, all the same width, one extending into the center of the field from each corner, left to be plowed in the manner indicated in figure 15.

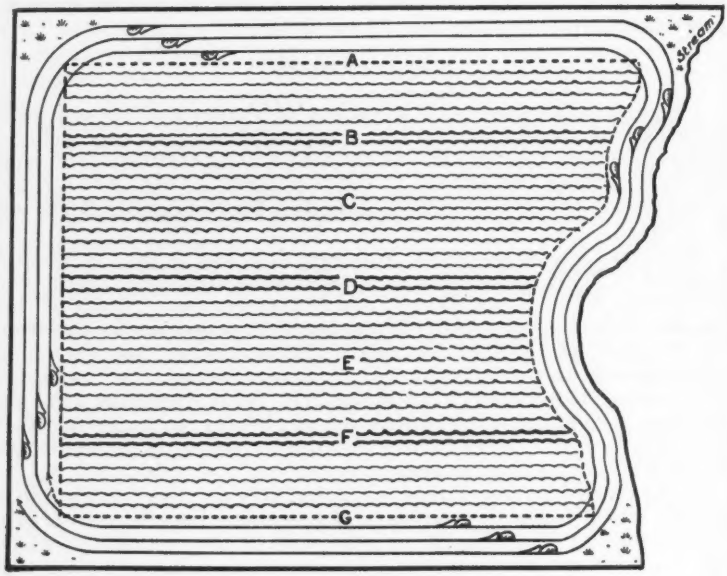

FIGURE 13.—Plan for plowing a field having one irregular side.

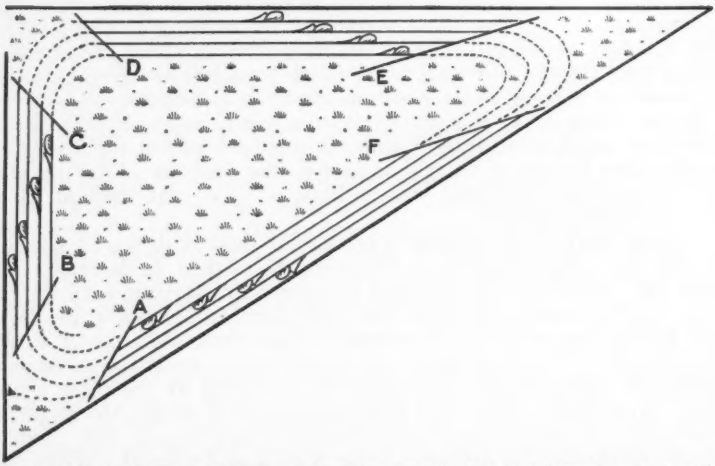

FIGURE 14.—An irregular field plowed by going around the field, lifting the plows at the turns, as shown by the dotted lines. The finish is shown in figure 15.

A four-sided field in which one of the long sides is not parallel to the other can be divided into two parts, one a rectangular plot and the other a triangular plot, as illustrated in figure 14. The rectangular part can be plowed in any desired manner and the triangular part as previously described.

If a field which would otherwise be rectangular has had a square

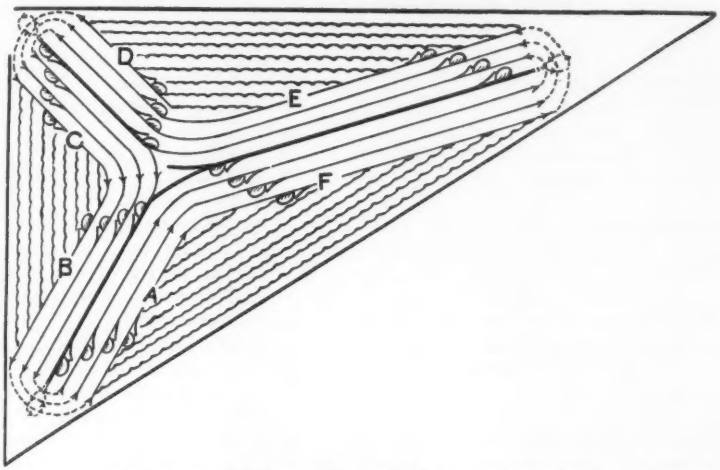

FIGURE 15.—Finishing the field shown in figure 14, leaving deadfurrows. The corners must be finished with a horse plow.

or rectangular piece taken off one corner for a feed lot, orchard, part of the farmstead, or the like, it will usually be better to make two separate fields in laying it out, with the imaginary dividing line between the two an extension of the line of the lot or orchard which is parallel to the longest side of the field.

When the character of the field is such that its contour must be taken into account, the best method of plowing will depend always on the peculiarities of the field, and it would be useless to attempt to give any general directions.

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